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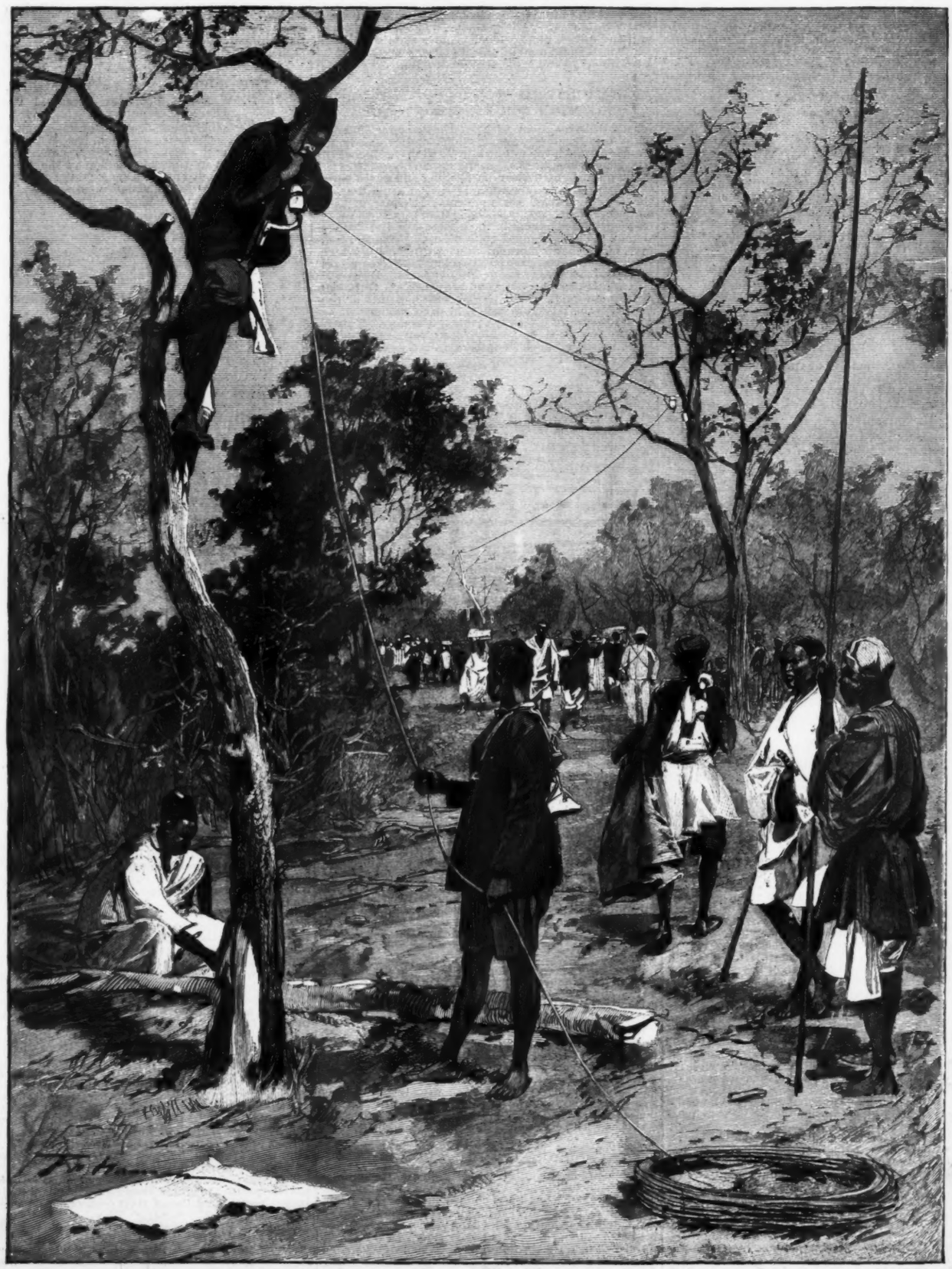


STRINGING A TELEGRAPH LINE IN THE SOUDAN.

THE TELEGRAPHIC SYSTEM OF FRENCH WEST AFRICA.

FOR many years past, public opinion in France has been alive, and very properly, to the ever increasing extension of the English submarine telegraphic system, which, at present, seems like a vast net thrown over the world.

Our own colonies, as well as those of Portugal, Germany, Holland and Spain, correspond with their respective metropolises solely through these English channels, which it would be very easy to interrupt at any moment and for any length of time.

Such enforced tutelage will bear hard upon us as long as private enterprise will not be able to obtain the confidence of the French treasury and to displace the capital still given so foolishly to foreign shadowy corporations.

A slight movement is manifesting itself in this direction. North and Central America, and even Brazil, are communicating with Brest without borrowing British cables, and the new organization will soon receive certain improvements.

A similar work is slowly elaborating on the west coast of Africa. It is certain that the day on which the cable from Saint Louis to Teneriffe is definitely acquired by France, our possessions, which extend from the White Cape to the mouth of the Niger, will have nothing to ask from the companies on the other side of the English Channel.

Without entering into considerations of political order, it is well to set forth the fact that commerce and the administration will not be slow to benefit by this new state of things through the sensible reduction of tariffs. Thus, at present, French Guinea, which was paying the West African Company 5·85 francs per word, is now sending its telegrams at 1·8 francs solely, say a diminution of 4·05 francs. The fact must not be lost sight of that this company receives, in addition, from our government, for each of the offices of Konakry, Grand Bassam, Kotonou and Libreville, an annual subsidy of 75,000 francs. Portuguese Guinea, which probably finds itself in the same situation, is thinking of asking for authority to connect her Bonlam, Favim and Jeba counting houses with the telegraph line constructed last year in Casamance, a province of Senegal to the south of the Gambia.

The German and English merchants established upon the Gold Coast, at Togoland and Lagos, who are very practical people, as every one knows, will not themselves hesitate to remit their numerous dispatches to our land lines if the tariff of the submarine lines is not changed. But such fine and desirable results will be attained, and especially preserved, only at the cost of a hearty support on the part of the colonies interested.

Our readers will certainly thank us for adding a few words concerning the progressive formation of this African system, the total length of which will exceed 4,800 miles.

In the first place, and up to a recent date, the different governors who succeeded each other, both in Senegal and the Soudan, merely took into consideration the possibility of giving their administrative orders a quick transmission. In measure with the effective conquest of the country, the lines were elongated. Thus, in 1862, Faidherbe, in order to maintain Cayor, which was continually in commotion, constructed the first line between Dakar and Saint Louis, and, after this, Colonel Pinet Laprorde, along about 1868, undertook to connect with Saint Louis the military posts which were situated along the river and were too distant from headquarters.

It took ten years to force the aborigines, principally the Toucouleurs of Abdul Boubakar, our irreconcilable enemy, to allow telegraph poles to be set up around their villages.

Medina, a station founded in 1855, and which a few years afterward had to sustain a memorable siege against the bands of the prophet El Hadj Oumer, did not, in fact, communicate electrically with Saint Louis until 1885, after the laying of a cable between Barbary Point and Teneriffe.

Our expansion toward the Niger, directed by the successors of Faidherbe, the Borgni-Desbordes, the Gallienis, and the Archinards, necessitated, as long ago as 1880, the establishment of electric conductors, which now radiate as far as to Segou and Nioro, connect with the Guinea system, and will soon join the lines of Dahomey and the Ivory Coast. This is the object that is now being pursued by Governor-General Chaudie, Colonel de Trentinian, and M. Ballot, governor of Dahomey, where the lines of the coast and those of Abomey, the immediate fruit of General Dodd's campaign, are continued to Carnotville.

Senegal, under the impulsion of its then governor, M. de Lamothe, began in 1893 the doubling of its communications with the Soudan, the correspondence of which was encumbering the sole existing line.

M. Bourrel, director of posts and telegraphs, and M. Magne, subinspector, had charge of this work, which they finished during the first month of last year.

These officials, who have just arrived in France on a sick leave, likewise, in a few months, successfully constructed a line from Konakry to Timbo and the Niger. The cost attending the execution of these vast projects is not so great as one might imagine. On the two last lines, those of Casamance-Boundon and French Guinea, the net cost per mile, inclusive of the purchase of all the exploiting material, did not exceed $40, while at home work of the same nature costs, upon an average, over $100.

It would take too long to enumerate the multiple causes of this great difference, but let us say in brief that it is due especially to the ease with which the supply of poles may be obtained right on the spot. Although sand prevails between Dakar and Saint Louis, and although alluviums are found in the deltas and upon the banks of the Senegal, in Saloum and Gambia, ferruginous stones form the elevations and about half the soil in the interior of Senegambia and French Guinea. The excavation of holes of from thirty inches to three feet in depth in this rock requires great effort, since the latter is so compact that it dulls the jumpers. So the wire is frequently strung upon high trees, as shown in our engraving.

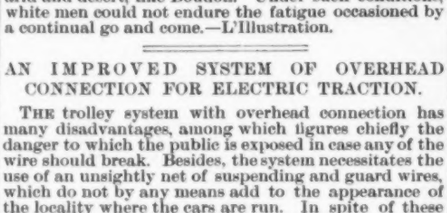
All of the operations connected with the construction of the line are performed by the natives, among whom there are sometimes some superior men, such as the old chief superintendent N'Dene N'Diaye, who, as long ago as 1862, participated in the establishment of the first line in Senegal, and was still traversing the forests of Fonta-Djallon at the head of his men last April. He is an energetic and gentle patriarch whom his men obey with veneration. Of a different character, but possessing remarkable firmness and intelligence, a second chief, Amadou Sar, has the faculty of giving endurance to the laborers, who never tire under his eyes.

Temperaments of this nature know no danger. So they did not flinch when last year the inhabitants of the fortified town of Sonkounda, who had promised to arrest the work of construction, refused to give a single bottle of water to the fagged-out gangs, and made the pirogues leave the shore of the Gambia, hoping thus to prevent the crossing of the country.

The recruiting of watchmen for the ulterior maintenance of the lines is effected from among the laborers who have shown aptitude and devotion. Devotion and courage are especially indispensable to men who, often in a foreign country (Senegal alone has up to the present furnished the personnel of this category), have to keep important sections in a proper state in districts that are sometimes mountainous, as Fonta-Djallon, or arid and desert, like Boudon. Under such conditions, white men could not endure the fatigue occasioned by a continual go and come.—L'Illustration.

AN IMPROVED SYSTEM OF OVERHEAD CONNECTION FOR ELECTRIC TRACTION.

THE trolley system with overhead connection has many disadvantages, among which figures chiefly the danger to which the public is exposed in case any of the wire should break. Besides, the system necessitates the use of an unsightly net of suspending and guard wires, which do not by any means add to the appearance of the locality where the cars are run. In spite of these and other faults, the overhead system is still the most frequently used, owing to the high cost of the installation of the underground connections. Recently, however, M. Bochet has brought out an invention which, while avoiding the guard and trolley wires, yet retains all the advantages of the overhead system. He couples two or three cars together and furnishes his train with a conducting rail, which passes certain points of contact with the second terminal in such manner that a constant current is sent through the motors. This result was attained by placing posts connected to the second terminal at such intervals that, as soon as the



ROTTSIEPER'S NEW TRACTION SYSTEM.

rear end of the rail left one contact, it became connected with the next at the front end. There is one serious drawback to this system, namely, that it requires a great number of posts along the track. Nor would it always be convenient to run several cars together. But based on a similar principle, another device was lately devised by a German, Herr Rottsieper. His arrangement offers the full advantages of M. Bochet's system, while only a few posts are required. In this German system a secondary battery is placed on the car and is charged fully at the terminal stations, while at places where a short stop is made as much current is sent into the accumulator as time permits. The advantages of this system are evident. Only a few isolated posts are necessary, there are no guard wires and the accumulators used may be of very light description, since they are recharged at comparatively short intervals.

Our illustration shows some details of the system. The accumulator on the car is connected to the rail, b; this rail touches the contact rolls, c, which are themselves in communication with the second terminal. The cable carrying the current is, of course, underground. At each stop there is a post under which the car is automatically brought into the circuit. The rail, b, is hinged so that it can be flapped down into the position indicated by the dotted lines, b 1. This merely for convenience. Instead of placing the rail on the top of the car, one might also attach one to each side of the car, flapping down the one not in use.

A modification of this system has the rail on the post, instead of on the car. In cases where cars have already been run on the old system, this modification will be made use of with advantage, if the guard wires and the posts are to be discarded, for the old rods by which the current was formerly carried from wire to motor may still be used, so that one change on the car can be dispensed with.

Our engraving is from Uhland's Wochenschrift.

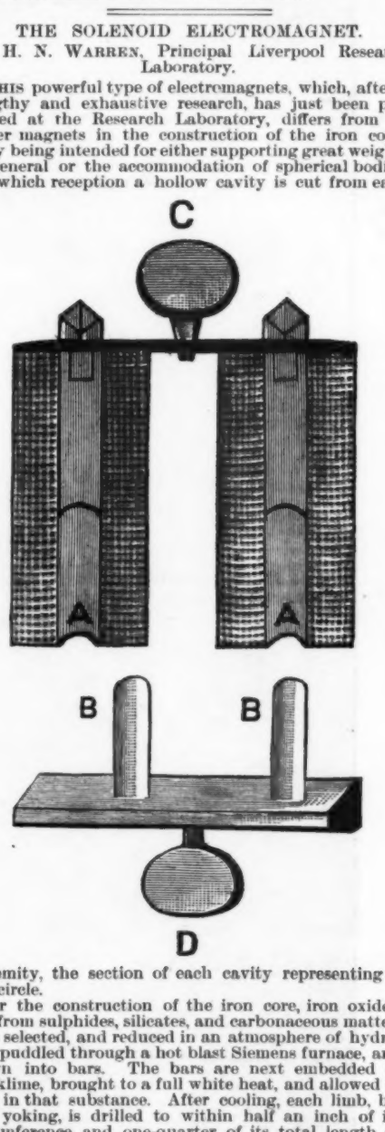
THE ORIGIN OF THE TELEPHONE.

OUR contemporary, L'Electricien, in an article under the above heading, seems to have taken it to heart that no French name has been connected with the invention of the telephone. It has, however, succeeded in satisfying itself that Charles Bourseul nearly invented it in 1854, some seven years before Reis. In an article published in L'Illustration of August 26, 1854, Bourseul raised the question of the possibility of transmitting speech by means of electric currents along a wire. The following passages, which occur in Bourseul's article, certainly show that he started work in the right direction. ". . . Imagine that one speaks near a movable plate which is so flexible that it does not lose any of the vibrations produced by the voice, and that this plate successively makes and breaks connection with a battery. You might have at a distance another plate which would make the same vibrations at the same time. It is true that the intensity of the sounds produced will be variable at the point of departure where the plate is vibrated by the voice, and constant at the point of arrival where it is vibrated by electricity, but it has been shown that this cannot alter the sounds. It is evident, at first sight, that the sounds will be reproduced at the same height in the gamut. The present state of acoustic science does not enable me to say à priori that it would be the same with syllables articulated by the human voice. . . . Any but the deaf and dumb would be able to use this means of transmission, which would require no apparatus of any sort. An electric battery, two vibrating plates, and a metallic wire would suffice. . . . Whatever happens, it is certain that, in the not very far distant future, speech will be transmitted by electricity. I have begun experiments in this direction. They are delicate, and require time and patience, but the approximations I have obtained make me anticipate a favorable result."—The Electrician.

THE SOLENOID ELECTROMAGNET.

By H. N. WARREN, Principal Liverpool Research Laboratory.

THIS powerful type of electromagnets, which, after a lengthy and exhaustive research, has just been perfected at the Research Laboratory, differs from all other magnets in the construction of the iron core; they being intended for either supporting great weights in general or the accommodation of spherical bodies, for which reception a hollow cavity is cut from each



extremity, the section of each cavity representing a semicircle.

For the construction of the iron core, iron oxides, free from sulphides, silicates, and carbonaceous matter, were selected, and reduced in an atmosphere of hydrogen, puddled through a hot blast Siemens furnace, and drawn into bars. The bars are next embedded in quicklime, brought to a full white heat, and allowed to cool in that substance. After cooling, each limb, before yoking, is drilled to within half an inch of its circumference and one-quarter of its total length (if the bar be less than half an inch from starting, a corresponding allowance has naturally to be made).

The diagram above illustrates the section of a magnet with its accompanying keeper, the separate parts being further described in the specified table. The magnet was constructed to suspend a weight of ten tons, and required to be excited by a current obtainable from twenty-five boron carbon cells only.

From the above diagram it will be readily observed that when the keeper is applied with its two iron projections, B B, which are constructed of such dimensions as to exactly coincide with the openings, A A, not only is the magnetic power fully utilized, but any side slipping of the keeper is absolutely impossible. All the magnets thus described were wound with No. 14 double cotton covered wire, the winding afterward being covered with paraffined insulation, wound with thread, and varnished with best electro shellac varnish. They are at present doing excellent service in researches on diamagnetism and polarization of light.

The subjoined table will better explain a few of the more important magnets thus constructed, and giving approximate quantities of their component parts:

Length and Diameter of Core.	Weight of Primary.	Voltage Required.	Weight Supported.
2 inches × ¼	4 oz.	6	8 lb.
6 " × ½	1 lb.	10	80 "
28 " × 2	9 "	50	5 cwts.
28 " × 4	100 "	50	2 tons.
36 " × 4½	112 "	50	10 "

—The Chemical News.

NEW DRY DOCK AT HAMBURG.*

THE shipbuilding yard and machine shops of Messrs. Blohm & Voss, at Hamburg, which for years have had in operation a large floating dock, known as the "Elb-dock," have just completed a new dry dock, which is the largest of its kind in existence.

This new floating dock has a carrying capacity of 17,500 tons. Its length, with the pontoons, is 624 feet 4 inches and its width 118 feet 1 inch. It is able to raise the largest merchant vessels that have thus far been built, and even the heaviest men-of-war, and consists of seven separate pontoons with high and strong sidepieces. These seven pontoons can be joined together, so as to form one connected system. Each sidepiece contains an engine and boiler room for the pumps and electric and hydraulic machines. These two machines have condensers and 700 indicated horse power each. They drive fourteen pumps, which are capable of pumping out the dock in forty-five minutes, and thus of raising the largest vessel in this short space of time. In order to regulate the raising and the lowering of the dock, it was necessary to divide each pontoon into several watertight compartments, which are closed by means of stop valves. All these stop valves can be moved from one point by means of hydraulic power, and the depth of water in all compartments is indicated by special apparatus. By this arrangement, it is possible for one person to manage all the stop valves and to direct the pumping.

The blocks upon which the vessel rests are easily movable by machinery from the sidepieces. Altogether, this new dock is supplied with the most modern improvements, some of which were specially constructed. The dock harbor behind the shipyard has a depth of 26 feet 2 inches below 0, so that, at ordinary high tide, vessels drawing as much as 26 feet can be docked. A bridge 118 feet long connects the dock pontoon with the shore, from which the dock is therefore quite accessible. Next to the pontoon and on the quay of the shipyard there is a huge crane, which, when projected 65 feet, can raise 150 tons, and 45 tons when projected 106 feet. By means of this crane, heavy loads can be transferred directly from the shore into the dock across the largest vessels.

Owing to its peculiar construction, this great dock can, in cases of emergency or in time of war, be transferred to Brunsbüttel, at the opening of the Kaiser Wilhelm Canal, to dock vessels which have sustained heavy damages or whose draught is great. As a matter of fact, it is capable of docking vessels with a draught of 29 feet 6½ inches. No vessel with a greater draught than 27½ feet has thus far succeeded in coming up to the port of Hamburg.

Upon applying to the owners of the dock, I was informed that no fixed schedule of charges for the use of the same had been or would likely be determined. It was believed to be more profitable to make special arrangements in each case. I was given to understand that not even the German government had been furnished with any tariff of docking charges, and that for the docking of foreign vessels of war it was probable that there would be charged about $975 for the first day and $250 to $500 for each following day. Messrs. Blohm & Voss desire it to be expressly understood, however, that they do not bind themselves to these figures.

There is little doubt that this capable and energetic firm, by the construction of the new dock, have met a long-felt want in Hamburg, whose docking facilities have of late years by no means kept pace with its shipbuilding. The Hamburg-American line especially will have reason to look with favor upon the new enterprise, as it will enable them to dock their express steamers and large freight boats in their home port, instead of having to send them to English or American docks.

The North German Lloyd, of Bremen, which also has some very large boats and is building more, will (as well as the German imperial navy) doubtless be glad to avail itself of these excellent facilities.

Although it is easy for persons connected with shipping to look them up in Lloyd's Register, I deem it not uninteresting to give, by way of comparison, the lengths of the largest graving docks in the world:

Docks.	Length. Feet.
Belfast	825
Birkenhead:	
No. 1	750
No. 2	930
Cardiff	600
Liverpool	768
London (Tilbury)	875
Newcastle (Wallsend)	520
Southampton	750
Antwerp	429
Cherbourg	508
Havre	535
Marseilles	593
Genoa	720
Baltimore (Simpson's)	504
Brooklyn:	
Erie No. 1	620
Erie No. 2	510
Newport News:	
At top	609
At bottom	560
Norfolk, Va.	500

It will be noticed that a large proportion of these graving docks are longer than Messrs. Blohm & Voss' new floating dock, which latter, however, far exceeds the dimensions of other floating docks in existence, the length of which is seldom more than 300 to 400 feet. It seems the builders desired a dock which could be transported to almost any part of the river below this port and also one which they considered superior to any graving dock for the safe handling of large and long vessels. W. HENRY ROBERTSON, Consul.

Hamburg, April 20, 1897.

Artificial Cider.—The following is a typical formula: 25 gallons (soft) water, 2 lb. tartaric acid, 25 lb. brown sugar, and about 2 pints yeast, are put in a clean cask, and after 24 hours well roused up. Then 3 gallons of spirit are added, the cask bunged, and left for two days. This formula is variously modified, according to taste, by the use of honey, cloves, whisky, etc.

* United States Consular Report.

ARMOR PLATE PRESS.

WE illustrate a double hydraulic press, constructed by Messrs. Hayward Tyler & Company, of 90 and 92 Whitecross Street, London, E. C., for bending armor plates. It is designed to work with a pressure of 2,900 lb. per square inch, acting in two inverted cylinders, each of which is provided with a return cylinder for lifting the ram when the pressure is off it. These latter cylinders are provided with screws and handwheels for regulating the height of the lift. The main cylinders have rams of 7¼ in. diameter and 25½ in. stroke, and are 3 ft. 7 in. apart, center to center. The size of the bed plate is 9 ft. 10 in. by 6 ft. 10 in. between the steel tension bars.

The head, bed, caps for the tension bars, main cylinders, and rams, with the return cylinders, are of cast iron. The return rams are mild steel. The rams are packed with U-leathers, and each is fitted with a square iron platen, secured by set screws. There are three hydraulic stop and relief valves, mounted on standards with copper pipes and bends, enabling the cylinders to be worked together or separately.—Engineering.

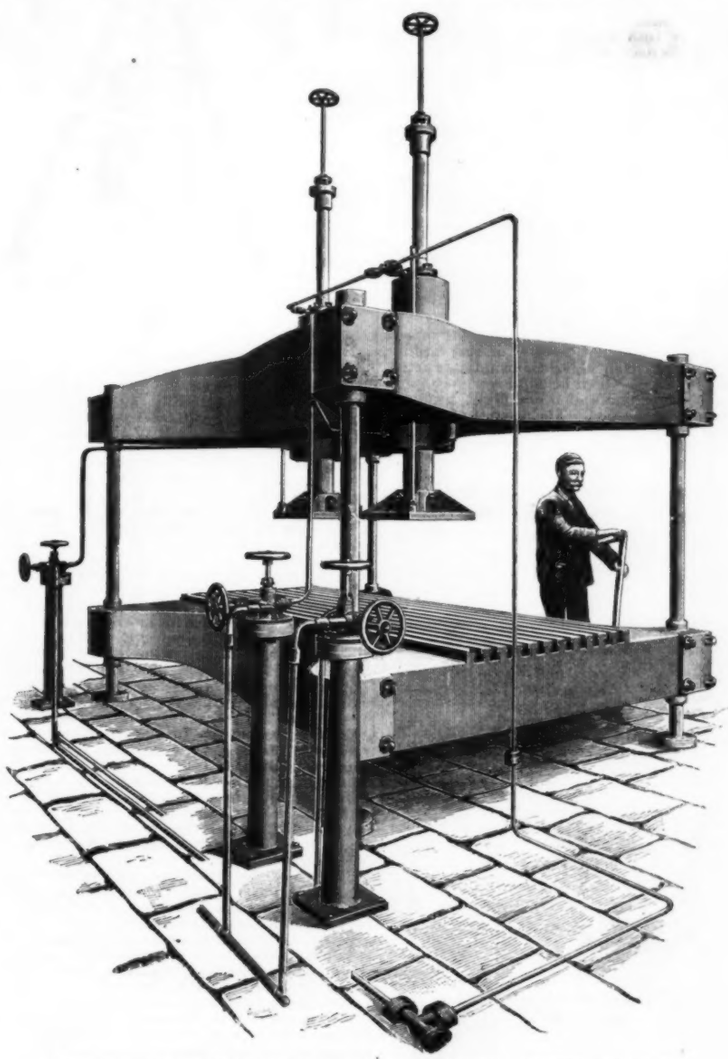
WIND AS AN AID TO FLIGHT.

By F. W. HEADLEY, M.A.

BIRDS understand wind and all its vagaries, and they turn them all to account. Many problems which men of science are compelled to class among those which they hope to solve some day, or, perhaps, despair of solving, a young bird begins to work out directly he is fledged. I will take some typical cases in which a bird derives help from the wind. It will be found that the wind, if it is to lift a bird, supplementing the work of his wings, or even doing all the lifting, must either move in an upward direction or, if it does not deviate from the horizontal, it must be of unequal velocity. A wind that is unequal, or not uniform, may either be made up of currents moving at unequal rates, or it may blow now gently, now strongly. A uniform horizontal breeze cannot lift or maintain a heavy body in the air unless that body has momentum of its own. It is no better than still air, since the bird—we must try to put ourselves in his position—becomes part of the moving current. The momentum required he derives either from his own wing beats or from the inequalities of the wind. When a bird rises with wings outspread and motionless, there must be inequality, supposing that the wind is horizontal.

A lark, when he is flying upward—always singing in spite of the steepness of the incline, as if to show how easy it is—invariably faces the wind. When he turns away from it he ceases to rise and generally loses elevation. When he wishes again to rise, he turns his head toward the wind. To take another instance: a cormorant, sated at last, wishes to join his comrades who are drying their wings on a rock not far off. The wind is blowing toward the rock in question; accordingly he begins by flying in the opposite direction, so that the wind may assist him as he struggles to rise from the water. This feat accomplished, he turns round and makes all sail for his destination. The lark and the cormorant are quite right in thinking that the wind will help to lift them, but it does so only because it increases in velocity as they rise. Near the surface of the land or the sea it is retarded by friction. An anemometer reveals a very marked increase in velocity at successive elevations not far from the ground.

By means of kites experiments have been made up to a height of a thousand feet, and even there the increase continues, though it is much more gradual. Were it not for this increase of velocity with altitude, the lark, after his first jump from the ground, would, but for his own efforts, move backward with the wind. It would not lift him any more than it will lift a balloon from which the gas has escaped. But perpetually passing from a slower to a more rapid current (in theory it is convenient to divide the air into definite strata), he has always an inertia which enables the wind to lift him. He is still, so to speak, part of the slowly moving stratum below when he emerges into the rapidly moving stratum above. In fact, he illustrates the principle of the kite—inertia, which is equivalent to momentum, taking the place of the string. As long as the kite is held by the string, it will rise; cut the string, and the wind will at once resign it to the mercies of gravitation.



DOUBLE HYDRAULIC PRESS FOR BENDING ARMOR PLATES.

We see then, that if a lark wishes the wind to help him to rise, he must face it—incline his body forward, as a kite is inclined; and, further, that the inequality of the wind must give him inertia or momentum, or else his wings will have to raise him without assistance. When gulls advance at right angles to the wind without any beating of their wings, the principle applied is the same. From some slight elevation they glide downward till they are near the ground or the surface of the sea, then (possibly by a twist at the waist) they turn suddenly and face the wind, which lifts them to their former elevation; after which the process begins again.

It may be that when birds soar, i. e., rise in spirals without moving their wings, they are availing themselves at each upward step of the increasing velocity of the wind. But they sometimes attain an elevation of a mile or more, and there the increase must be a negligible quantity, if it has not at length reached the vanishing point; and, therefore, we have to look elsewhere for an explanation of soaring.

This brings us to the subject of up currents, obviously much to be desired if wing labor is to be saved; and birds, whenever such assistance is to be had, are always ready to profit by it. When the wind blows against a cliff, it is, of course, deflected upward, and gulls may sometimes be seen enjoying the fun of being lifted like a foam bubble by the up current, then descending to

be lifted again. Oftener they may be seen soaring over cliffs or hills near the shore, ascending in noble spirals without a motion of their wings. The secret lies in the upward slant of the wind. But soaring may be seen under quite different circumstances. The adjutant bird, one of the noblest of soarers, rises till he looks a mere speck or vanishes altogether, over the plains of Burma. Can there be up currents there? It is possible that, owing to the ground being unequally heated by the sun, there may be such currents here and there. But in Egypt I have seen kites soaring over fields where the young corn was growing thick and green, and where, consequently, the earth's surface was not much heated. Probably the adjutant depends on the irregularity of the wind. Even what we call a steady wind, we know by Prof. Langley's experiments, is very unsteady, and varies enormously in velocity from one moment to another. This fact the adjutant may make use of, deriving from it the indispensable inertia or momentum. As long as he can offer resistance to the breeze, not being carried by it like a balloon, but feeling it blowing in his face, so long the breeze will continue to lift him. Whenever the wind freshens he will turn and face it, and will rise like a kite. When it slackens he will sail with it, descending slightly. Obviously there will be a good deal of leeway, a phenomenon vouched for by good observers; but there will be a gain in altitude. And thus the grand bird, making even the wind, that "chartered libertine," his slave, rises higher and higher—often, no doubt, watching as he soars for carrion on the earth below, but often, probably, delighting only in the cool upper air, and in the exercise of his own skill.

To descend now to a humbler but very wonderful performance. Gulls may often be seen following in the wake of a steamer without a motion of their wings, though the wind is blowing strong in their faces. They are taking advantage of an up current. As the steamer advances, the air at the stern rushes down to prevent a vacuum being left, and this down draught rebounds off the surface of the sea and a strong up draught is formed. The gull puts himself in this up draught, which lifts him like a feather weight, then he glides downward and onward at a great pace. Meanwhile the point at which the up draught is formed advances. He soon finds himself in it again, is raised to his former elevation, and the process is repeated.

But often a gull will hover over the stern, apparently almost motionless, in reality steadily advancing with the steamer. Here, too, there must be an up current, the wind blowing at a slight angle to the steamer being deflected upward when it strikes her side. This buoys the gull up. In rising he loses way; when he advances, he descends. But he does not descend or rise rapidly, as in the case last described. Like a consummate artist, the gull conceals the art which he employs.

For the solution of this and other flight problems more observations are needed. The interest of the subject will amply repay anyone who will devote time and energy to the study of it.—Knowledge.

[Continued from SUPPLEMENT, No. 1131, page 18078.]

PERPETUAL MOTION.—III.*

THE force of gravity applied directly to the dropping arms of wheels, or to balls which roll out in troughs, fails to make such machines operate as self-movers.

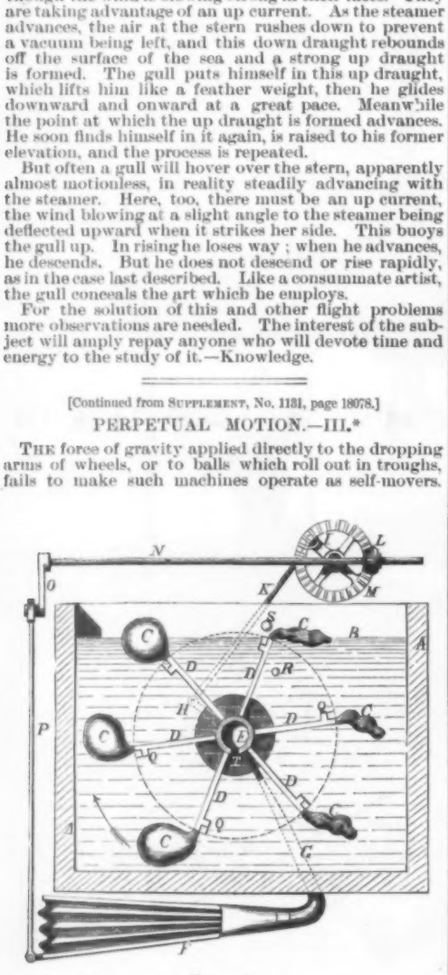


FIG. 11.

Inventors have sought often to utilize the buoyancy of floats in a similar way. The accompanying diagram illustrates this principle.

A is a cistern of water, filled as high as line B; C are six bladders, communicating by the tubes, D, with the hollow axle, E, which axle is connected with the bellows, F, by the pipe, G. H is a crank, connected with the crank, I, by the rod, K. L is a bevel wheel, M a pinion, N its shaft. O is a crank, attached to the bellows, F, by the rod, P. Q are valves with projecting levers. R and S are two projecting knobs. T is a hole in the axle, E, forming a communication with it and the lowermost bladder. The axle, E, being put in motion, is expected to carry round the bladders and tables, and by the cranks, H and I, and the connecting rod, K, cause the wheel, L, to revolve, which, communicating a similar but accelerated motion to the pinion, M, shaft, N, and crank, O, works or blows the bellows, F, by the rod, P, from which the air enters the axle, E, by the tube, G, and passing through the hole in it at T, enters the lower bladder, C, by the tube, D; this bladder being thus rendered lighter than the space it occupies, ascends, bringing the bladder behind it over the hole in the axle, T, in like manner, and which is thereby expected to gain an ascending power, producing a similar effect on the one behind it. When one of the bladders arrives at the knob, S, the lever of the valve, Q, strikes against it, and opens the valve; when the bladder arrives at U and begins to descend, its pressure on the water drives out the air, and gives it a descending power; the knob, R, then closes the valve, Q, and prevents the entrance of any water into the bladder; by this contrivance, three of the bladders were expected to be alternately full and empty, according as they passed over the hole, T, or the knob, S.

The reason assigned for the failure of this machine was the friction, the old invincible enemy of perpetual motion seekers.

Amid all the fruitless attempts which have appeared,

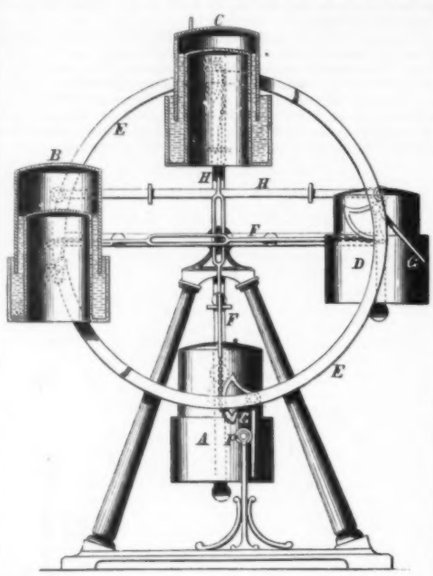


FIG. 12.

there was still one avenue to the object of pursuit, to which the common and well-known principles of hydrostatics seemed to direct the way; this was the principle that any body specifically, or bulk for bulk, lighter than common air, will rise and swim in it. Consequently, if a certain quantity of vessels are attached at equal distances, round the circumference or rim of a wheel, so contrived as that one-half of the vessels shall be exhausted on one side of the wheel, and the other half filled with air on the opposite side, in this case the exhausted vessels will attain the highest part of the wheel and the full ones the lowest. But to render the matter more explicit, we must refer to the annexed engraving, Fig. 12.

A B C D are four vessels connected to the wheels, E, by round pins which project from the vessels on each side, and enter into corresponding holes in the wheels, E. The wheels, E, are intended to revolve by the space under the vessel, B, being a vacuum, and therefore lighter than the same portion of air; a little before the vessel, B, reaches the highest point of the wheels, it begins to close, and opens the opposite vessel, D, in the same manner as the vessel, C, opens A, because the pressure of the atmosphere on the vessel, C, is equal to the pressure on A. Instead of common packing to make the vessels airtight, mercury is substituted, which has less friction, and is never out of order. The particles of mercury not being entirely free from friction, a little power is requisite to open and shut the vessels; this is expected to be effected by the rods, F, connected to the lever, G, by chains. The rods, F, give motion to other rods, H, by the rollers acting against collars on the rods, H, not shown.

The levers, G, are successively worked by sliding over the roller, P. The connecting rods, H, are so adjusted as not to draw the vessels out of their upright position, which would let the mercury escape; also, the lower vessels, A and D, are made rather larger in diameter than B C, so that the pressure of the atmosphere may counterpoise the weight of the vessels, A C and B D, with their connecting rods.

The inventor of this contrivance says:

"I doubt not in the least, that if a pneumatic machine like this were accurately executed, it would continue in perpetual motion; yet I still think the power might be greatly increased by placing the whole engine under a receiver of condensed air, say from ten to twelve atmospheres, which would weigh, if it were ten atmospheres, about twelve ounces per cubic foot."

In 1865, Herman Leonhardt, of St. Gall, Switzerland, invented a new motive power engine, which he thus describes:

"I avail myself of the property of bodies or objects of a certain specific gravity, when immersed in a fluid of a greater specific gravity, to rise or ascend to the surface of such fluid. This buoyancy represents a greater or lesser force or power, according to the greater or lesser difference between the specific gravity of the object and that of the fluid, and the size of or the displacement caused in the fluid by such object. In order to make the said objects, which I will call floats (see Fig. 13), as light as possible, and yet strong enough to resist the pressure of the water, I construct them of thin sheet metal, and in preference, in the form of tubes or hollow cylinders with flat ends. A number or series of these cylinders placed horizontally parallel to each other are hinged or linked together in a similar manner as the buckets of a chain pump; this chain of floats is passed over two sets of pulleys or disks fixed to two horizontal shafts, the one placed vertically above the other, the said pulleys being formed to suit the diameter of the floats. One-half of this chain of floats passes through the center of the tank holding the water or other fluid, and the other half passes outside the tank through the air. The floats, when in motion, enter through the bottom of the tank, in the manner hereafter described, and rise up by their buoyancy through the water; they then pass round the top pulley, descend outside the tank, and passing over the bottom pulley, again enter the tank, and so on. If cylindrical floats are used, as described, they are fixed on the connecting links half a diameter or more apart from each other; therefore, supposing the floats to be fifty centimeters in diameter, they would be placed twenty-five centimeters apart.

"Now the principal part of my invention consists in relieving the floats, when entering through the bottom of the tank, of the pressure of the water column, which pressure, if not removed or neutralized, would render the rising of the floats in the water impossible, and prevent the machine from acting. The manner in which the floats are relieved from the pressure of the water column when entering the tank is as follows: On the bottom of the tank I form an entrance chamber for the said floats of a depth equal to the diameter of a float; the bottom of the chamber and its top are each provided with double slides which open and close as the floats enter and leave the chamber. Supposing the floats to be in motion, and one of them to have arrived in the center of the chamber, a lever actuated by the moving floats or by the revolving float pulley or disk will cause the top or egress slides of the chamber to open in the same measure as the float rises; this slide, acting through another lever, will, at the same time, open a slide or valve in the side of the chamber and admit water into it, thereby bringing the water in the tank and in the chamber into equilibrium. When one-half of the float has passed through the top or egress slide, the next float will have arrived at the botom or ingress slide, which latter will now open in proportion to the rise of the float. The egress slide will close in the same measure and at the same time shut off the communication between the tank and the chamber, which was necessary for establishing the equilibrium. At this juncture other valves connecting the chamber with pipes leading to the top of the tank are opened, and the water in the chamber, which would be detrimental to the further rise of the entering float, is withdrawn through these pipes, which I will call return pipes, by suction, and allowed to flow back into the tank above the water level; this suction is effected through the following arrangement: That portion of the top of the tank where the floats leave the water is open, but the other portion of it is covered, and a partition dividing it from the open portion is made to dip into the water to some depth, thereby rendering it a hermetically closed chamber, and the above mentioned return pipes open at a certain height above the water line into it. This chamber I call the vacuum chamber, because previous to starting the machine a vacuum or a partial vacuum must be formed in it, and afterward maintained as long as the machine is to continue in operation. The air is exhausted from the chamber by

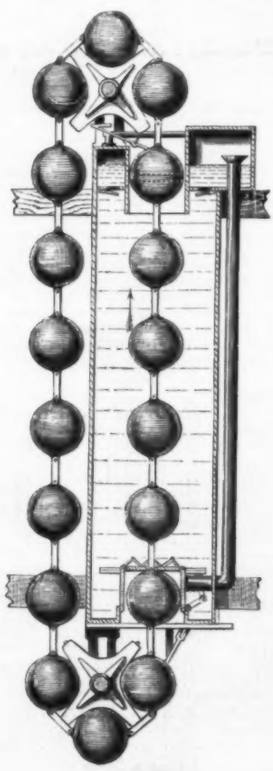


FIG. 13.

means of an air pump driven by the machine, but arranged for driving by hand for the purpose of starting the machine. By forming this vacuum the original water level in the tank will be disturbed, the water level being raised in the vacuum chamber and lowered to a corresponding extent in the open part of the tank. Supposing the tank to be of a height to hold six floats, 1, 2, 3, 4, 5 and 6, 1 being the one above described, as entering the admission chamber, it is clear that as 6 leaves the water, the water level in the open part of the tank will be lowered in proportion to the displacement previously caused by 6, and the water level in the vacuum chamber being thereby likewise lowered, it will cause a suction or drawing up of water in the return pipes, equal in quantity to the amount of water displaced in the entrance chamber by the entering float, 1. The water sucked up through the re-

* Reprinted from the SCIENTIFIC AMERICAN, 1870-71.

turn pipes will flow over into the vacuum chamber and distribute itself in the water of the tank. The ingress and egress slides of the entrance chamber are furnished with linings or packing of felt previously boiled in oil for insuring a watertight fit against the floats without much friction, and the flat ends of the floats likewise pass between sheets of felt previously boiled in oil and pressed against the flat ends by fluted rollers. The air pump is maintained in operation in order to remove the trifling quantity of atmospheric air adhering to and introduced into the tank by the entering floats. The motion communicated by the rising floats to the float pulleys or disks and shafts is further transmitted by means of belts or other gearing, in the manner usual with other motive power engines.

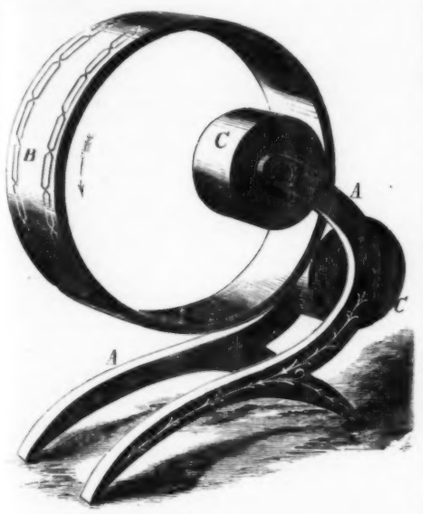


FIG. 14.

"The details of arrangement and construction of my new motive power engine may be altered or varied, but the main features of my invention consist in relieving the floats when entering the tank of the pressure of the water column by means of a vacuum chamber and parts connected therewith, as described, or their equivalents."

Only about a year since [1870] the London Mining Journal described a machine, patented in England, the essential features of which did not differ from those of Leonhardt; and what is more, expressed a favorable opinion of it.

We have received several letters with diagrams of "perpetual motion machines" from correspondents, one of which we will herewith present and defer others for future articles.

Fig. 14 is a diagram sent us by F. G. Woodward, whose address was not given in his letter.

The writer says: "It consists of a stand, A, two idler pulleys, C, between which a hollow cylindrical ring, suspended in the manner shown, is expected to revolve in the direction indicated by the arrows." The only difficulty about it is that it will not work, though it looks plausible enough.

Fig. 15 illustrates a piece of folly which, we are sorry to say, has been repeated in one form and another so

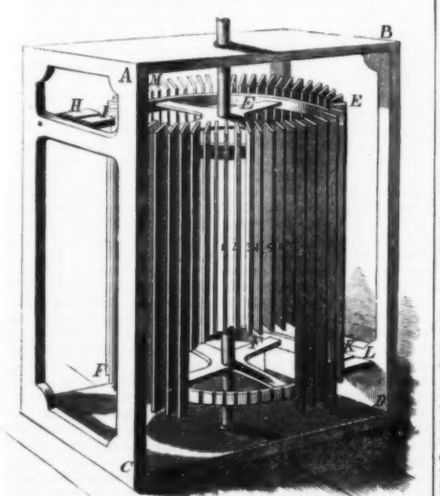


FIG. 15.

many times that it ought to be considered a standing joke, but which is nevertheless constantly turning up as a serious proposal among a class of inventors who know little or nothing of electricity and magnetism. It is the device of a Dutch inventor, Hero Hicken by name.

A B C D represents a frame of brass or wood for the machine. E F, to run in.

E and F are two brass wheels, similar and equal, fixed upon a movable axis, G.

1, 2, 3, etc., are a number of artificial magnets, placed within the teeth of the wheel all round, and as near each other as is possible, provided they do not touch; their north poles at E and their south poles at F.

H and I are two similar and equal magnets fixed in the brass plate, A C, very near each other, but not touching.

K and L, two more fixed in the brass plate, B D.

Now, as the north pole of one magnet repels the north pole of another magnet, and attracts the south; and inversely the south pole of one magnet repels the south pole of another, and attracts the north; so the south pole, I, attracts all the north ones at E; and the north pole, H, repels all the north ones at M. In like manner, K attracts at N, and L repels at O, and by this means the whole machine, E F, is expected to move perpetually round.

Now this would be all lovely if magnets did not attract in more than one direction. Many American inventors have tried the same principle over and over, only to find their wheel standing still, and have then sighed for some septum which, interposed between a magnet and its armature, would prevent attraction while thus interposed. The editorial sanctum of the SCIENTIFIC AMERICAN has often been compelled, in answer to correspondence, to confess its ignorance of any substance of which such a septum could be constructed. Humiliating as is the confession, we never have heard of this long sought for desideratum, and what is more, we expect to leave this sublunary sphere before its discovery. But we do expect, judging from past experience, that about once a month some sanguine inventor, who thinks he has discovered the perpetual motion, "all but that one single thing," will expect us to point him the way to success by supplying to him (privately, of course) the knowledge of the septum sought.

This idea of a magnetic perpetual motion is just now the most prevalent one of all, and if what we have said shall serve to open the eyes of the many who are eagerly following what must prove to be only a delusion and a snare, our purpose will be accomplished.

Fig. 16 is an engraving of a supposed self-moving machine sent us by S. H. Davis & Company, of Detroit, Mich. They state that it is the invention of the late William Davis, of that city, who spent a great portion of his time in the attempt to make a self-moving machine.

A, in the engraving, is a tank containing water, as shown. The hollow arms, B, communicate with a hollow shaft, C, and the bellows, E; screw valves, D, being employed to increase or diminish the area of the passages in the hollow arms, B. Each of the bellows, E, carries a weight, which, during a portion of the revolution, compresses the bellows and forces the air out of

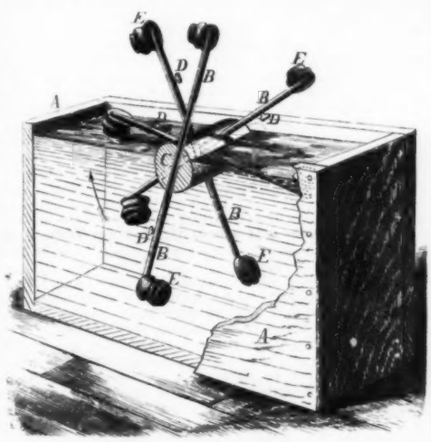


FIG. 16.

it through the hollow arms, B, and shaft, C, into bellows upon the opposite side of the wheel, which, being inverted, are expanded by the action of the weights, and their buoyancy being thus increased on one side of the wheel, the latter is expected to turn constantly by virtue of the effort of the expanded bellows to rise to the surface. This is one of the most plausible devices we have ever seen, and it will puzzle many to conceive the real reason why it will not move as it is expected to do. The fallacy will be, however, apparent to those who are familiar with the laws which govern the pressure of fluids, and who know that whatever buoyant power a body will exert in rising out of a liquid in which it has been immersed, is precisely that which was expended in forcing it below the surface to the point from which it begins to rise.

Says M. de la Hire: "There is not any of those who pretend to have found out perpetual motion, who do not agree that two weights placed in a position to move, following their natural direction in equal time, or in any way reciprocal to their weight, remain in equilibrium. Yet there is no perpetual motion scheme where one cannot draw a conclusion quite opposed to this principle; for, whatever may be pretended, perpetual motion is nothing more or less than the elevation of one weight to a certain height by the descent of another weight at the same time; and reciprocally the restitution of the first to the place where it was before its movement, by the descent of the one that had been raised, and so on ad infinitum; sometimes by means of weights, which, being raised, in their fall agitate other weights; sometimes, by means of liquid bodies, which, being raised, can run and move other parts far separated from the center of motion; from which no advantage can be derived and which is entirely contrary to the preceding principle.

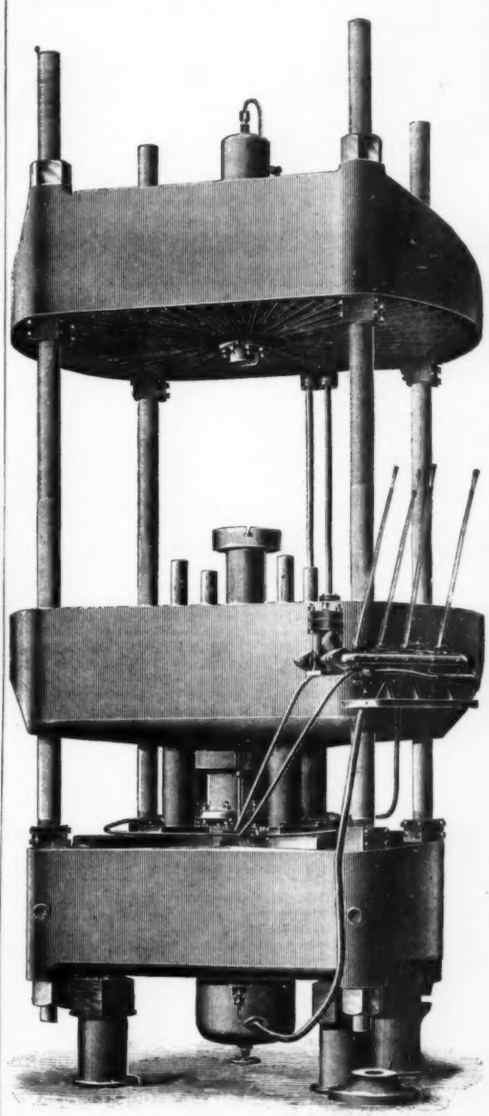
"Those who occupy themselves with this chimera find nothing but embarrassment, for generally their machines have so many weights, etc., to move them that their inventors forget always to be on their guard against the many hindrances that arise—the height, etc., of the powers employed, their natural direction, etc.—all these are sometimes so strangely jumbled together, that it requires very hard work to be able rightly to distinguish them. This is one great reason that leads such persons to a false demonstration of perpetual motion; and when they propose their beautiful inventions to those who are versed in science and who cannot immediately make them see or understand in what way their reasoning is false, they then publish to the world that the very cleverest men have been convinced of the truth of their perpetual motion."

HYDRAULIC FLANGING PRESS.

HYDRAULIC flanging on locomotive boiler work, although in use for some years in this country by private railroad companies, has until recently been employed only to a limited extent in the United States. The Schenectady Locomotive Works, upon investigation of the matter about two years since, contracted for a hydraulic flanging plant with the Morgan Engineering Company, of Alliance, Ohio. The design of the press, which is illustrated herewith, was worked up very carefully with a view of adapting it to all classes of locomotive boilers in use in the United States.

The main table is 10 ft. 3 in. wide by 14 ft. long, the maximum width between the upper and lower tables being 11 ft. The minimum height between the upper and lower tables is 4 ft. and the sizes of the rams are as follows:

One main ram, 28 in. in diameter; one internal clamping ram, 14 in. in diameter; four radial clamping rams, 6 in. in diameter; one inverted top ram, 10 in. in diameter. The main columns are of steel, 7½ in. in diameter by 27 ft. long. The total pressure exerted



HYDRAULIC FLANGING PRESS.

by the main and radial rams only, with a regular working pressure of 1,500 lb. per square inch, is 550 tons.

This press has now been in use by the Schenectady Locomotive Works for the past year and a half. The press produces, of course, work of exact uniformity, similar parts made from dies being exact duplicates in size and form, while the effect upon the steel in flanging is very much less severe than that produced by handwork with alternations of heating and flanging. It is also found that the flanges turned by the press are softer than those turned by the ordinary method of heating and flanging by hand.

The various forms of plates are heated in a large furnace, the fuel for which is oil, and after the flanging is performed the plates are still at a red-hot heat, so that the work is practically free from strains when completed.

Flanging dies have been made for their standard design of locomotives by the Schenectady Works, and the works find that quite a number of railroad companies are calling for hydraulic flanged boiler plates in their specifications—a practice which cannot be too highly recommended. The Schenectady Works are also using, as a standard practice, the pressed steel boiler

front and door, pressed steel cylinder head covers and steam chest casing covers.—Engineering.

IMPROVIDENT CIVILIZATION.*

A PLEA FOR THE APPLICATION OF SCIENTIFIC METHODS TO THE AMELIORATION OF SOCIO-ECONOMIC DEFECTS AND DISORDERS.

By RICHARD T. COLBURN.

THE responsibility you have seen fit to place upon me I will now ask you to share with me.

The controversy in respect to a bimetallic money standard, and the other as to the limits of safety for representative or currency money, are certain to be fully worked over, by the powerful vested interests concerned, in reports of commissions and printed volumes. I devote a minute or two to explaining that they are but parts of a far greater question of metrology, one also requiring for its elucidation a more exact knowledge of the laws of thought than we at present command.

The traditions of a people mould its opinions, and they change but slowly. The advance of knowledge has to overcome this inertia. Our present civilization, all types of it, are apt to be lopsided; its contour is asymmetrical; it is not abreast of the knowledge of the time, and is not yielding to mankind nearly the amount of comfort and well-being it might be made to do. To the social philosophers may be credited much of the improvement of the past hundred years. From a great number of social ills, defects and shortcomings, due chiefly to this overlapping of the childhood of the world upon its adult stages, I select a few of the more serious, which will require many centuries to correct themselves, in order to raise the inquiry among you whether it is not within the compass of human endeavor to accelerate a better state—not merely to gratify an altruistic impulse, nor yet in fulfillment of ethical ideals, but as a deliberate choice of diverging policies.

I. THE WASTE OF WARFARE AND ARMAMENT.

Ahead of its logical order, I take up the waste of war and constant preparation for war, which has haunted mankind, with few and trifling exceptions, as a malign heritage as far back as we can trace. History, whether printed in books, written on parchment, engraved on monuments, or burned in clay tablets, seems to be mainly a record of combats and glorification of warriors. Truly enough, the overrunning and subjugation of one community by another of alien looks or speech was one of the most impressive and awful calamities, surpassing in its mental impress that of earthquakes, eclipse, drought, forest or prairie fire, flood, or insect pests, because strong sinews and courage availed to give relief in one case, but not in the other. Training to arms was the ordinary occupation of life, and death by wounds, or from privations in camp, the exit, while the greatest honors were paid in primitive as in modern times to warriors.

We need not resort to any superstitious legend to account for this combative instinct; it has its analogue among the brutes which bristle up and stand on their guard at the coming of a strange figure and, in the time of scarcity, fighting for the available supply of food, shelter or females. It is even so with man; finding himself within a zone or clime-bound belt of fertility subject to periodical encroachments of the ice cap from the one direction and to the fierce suns and tropical growths on the other, hunting and fishing his principal pursuits, agriculture being nascent, there were ages when subsistence was precarious, when, along with the fera naturæ, he was driven to the caves and trees, and had to contend for his very existence against organic and cosmic foes. The character of combatant, strengthened from generation to generation, became a first nature; he must be ever on the alert for a foe and for an occasional rival. Essentially gregarious, man could not, until very recently, associate in large numbers without engendering an artificial struggle for existence superposed on the natural.

Until the dawn of systematic agriculture, the food products of a given terrain could not keep pace with the population; not until the dawn of modern navigation was the drawing upon far distant or more fertile regions practicable; the extinction of the feeble and unskilled was therefore a foregone conclusion. Even so lately as the time of Malthus, it was held that Nature, having by her scheme of fecundity provided twenty partakers to her table spread for ten, the excess must disappear in some way by struggle or disease. It was not surprising that both philosophers and statesmen could reach the conclusion that every generation, or each quarter of a century, must have its great war in order to thin out the population to the capacity of the soil for sustaining it, or otherwise to conquer enough more territory for the purpose. The tendency of this war spirit, thus kept alive, was to diminish the population at one end of the series in order to add to it at the other. It is a late discovery that this guaranty of the sufficiency of subsistence can be more easily and effectually obtained without fighting than with it. Aside from mutual jealousy of neighbor nations, or the fear of subjugation by one or more, the policy of fighting, in order to live, can be shown to be a colossal blunder. Man need no longer exterminate his own species to escape starvation.

Had the ordeal of arms remained as it began, with a biting, scratching and wrestling, not much above the wolves, in which brute strength, sharp claws and teeth, and endurance prevailed, the perpetuation of the more warlike, and the extinction of the peaceable, must have operated to keep man closer in physique and mind to the brutes. A series of inventions of weapons, the sharpened spear, then the bow or flint tipped javelin, the arrow, the projectile, the fulminating powder, the domestication of beasts and birds—all so many triumphs of mind in the control of natural forces—enabled men to ward off the cosmic dangers and to beat back every other possible foe. Hunger and thirst and cold he had to contend with, as they had; soon he had their skins to warm him; he need not hunt his dinner before eating it; he could entrap it, and later employ the tame animals to help.

This great emotional source of wars, mutual distrust, suspicion and aggrandizement, remains with nations, as with men. When each was his own advocate, judge and executioner, the fear of combat was less than the fear of declining battle—the dread of a charge of cowardice. May we not look forward to a time when war growing out of distrust or wounded vanity shall become as obsolete among civilized people as the hunting habit, the duel, or pugilism, to which it bears a close resemblance? Perhaps, if we can demonstrate the absurdity, the folly and waste of it, we may do something to banish oppressive armaments; but the war impulse is scarcely amenable to reason, or to considerations of profit and loss; it is more vulnerable to ridicule and to the banishing of deep seated prejudices. This power of fear, rivalry and suspicion being an inherited mental trait, dating far back in man's career, nurtured by song and story, embellished by poetry and art, stimulated by a religious enthusiasm, will die slowly. Like the beliefs in fairies and witches, they are not to be uprooted by argument alone but must be outgrown.

The devolution of the fighting trait may be traced, where one would least expect to find it, among the females. Women, young and old, higher and lower, instinctively, as we say, admire physical bravery, often in preference to moral courage. The very same badges and insignia of war stir the fierce emotions more than in the males. The showy uniforms, music and bearing, the plaudits of victory, rouse them to unwonted enthusiasm. Favor is extended to the side of the conquerors, disfavor to the vanquished, as eagerly as compassion on the wounded and dead. Unconsciously it may be, women are great aids to the recruiting sergeant, and to the gladiatorial shows, pomps, pageants and circuses. The songs of all nations reflect this powerful stimulus toward battle. "J'aime que le militaire," "The bold soldier boy," is the tenor of them; and, as if to intensify and keep alive the belligerent instinct, the boy children are still given weapons as playthings. Very rare are the plaintive songs in denunciation of war. I remember one such in fashion in the first half of the century. It ran something like this:

"If I were King of France, or still better, Pope of Rome,
I'd have no fighting men abroad, no weeping maids at home,
But the world should be at peace; and if the kings must show their might,
Then should those who made the quarrels be the only ones to fight."

Traces of the same surviving habit, grown dim from disuse, are found in the fainting or swooning disposition at the sight of flowing blood. A variation of this may be found in an attack of frenzy, or fury, from the same cause. This trait is also noticeable in some animals which are excited by the red color alone. The expression "war fever" is apt; it begins in delirium and ends in lassitude and exhaustion. The persistence of the belief that "blood letting" is the natural cure for personal or social ills is a survival of the same kind. The passion for military prestige—la gloire—which so long haunted the Romans, and later the French, and is now conspicuous with their neighbors, is a fatal inheritance which lingers along with great intellectual power.

When one speaks of "firing the national heart," appeal is made to this latent instinct, and it rouses the inbred emotions in much the same way as its opposite emotion, the stampede of panic. Something of the same cruel homicidal impulse is to be seen in the old-fashioned "hue and cry" against alleged infractions of decency, loyalty or sacrilege and in the craze of mobs for lynching. Strategy and artifice may avail to divert it, or lead it to harmless issues, but it cannot be extinguished at the onset by threats or any reason short of that of exhaustion by superior force. This accentuates the danger, at all times along frontier lines, of an incident of encroachment or insult which may serve as a spark to ignite combustibles. The great concern of statesmanship is to keep this latent tendency from flaming into open war. "The cancer of a long peace" no doubt reflected a state of society in which industry was dislocated, when possessions were held by the strong arm, which indeed must have been wretched to make a state of war more tolerable.

Man will fight to expel intruders upon his domain, to resist capture, to overcome sexual rivals, to protect his family and to preserve his altars and property. Modern wars spring more frequently from the latter than from all other causes combined; to be secure in the enjoyment of property, excuses and renders possible the armament of advanced nations as a reserve of police force, to maintain domestic peace and order, although the supplies are generally voted after artificial war scares. Holders of wealth are willing to be taxed to insure tranquillity at home, even at the risk of personal conscription, rather than be left at the mercy of mob violence. Such is the irony of our civilization that some of the leading nations manage to combine a treble profit by fomenting or permitting wars in which the combatants become customers for arms, ships and munitions, and also for loans of money.

An appeal to force, to establish and maintain any degree of equality or inequality of fortune, is a mistake. It puts force in the place of equity; fixes right by might; moreover, it fails of its object; armament for domestic purposes excites alarm among neighbors, who have similar pretexts, and thus the Sisyphean task is kept up. Besides, it tends to invest property holding per se with a sacredness which ought not to belong to it.

The maxim of aggressive statesmen, that "constant preparedness for war is the best security of peace," is a seductive, dangerous half truth; it is about equivalent to the old adage that every gentleman should spend an hour a day with foils and pistols to keep himself in practice against intruders, assassins or robbers. Some ultimate appeal to force, of course, there must be; but, like the enforcement of decrees of courts, it should rather be in posse than in esse.

The world presents, at the close of the century, three very instructive object lessons in the policies and prospects of three continents — Europe, Africa and America. When the first Napoleon made his menacing prophecy that "in fifty years Europe would be either all Cossack or all republican," he indicated correctly enough the two opposing forces between which it is kept in unrest and arms. He simply underestimated the time for working out. The six great powers waiting for the recovery, or expiring gasp, of their feebler neighbors, in order to obtain a share of their estates, is a sad spectacle. How many more furious struggles is history to record for the control of the Levantine shores? What a satire on civilization—not to speak of Christianity—to find the youth of Europe armed for such wanton waste! Turkey, Austria, Greece, the Balkans, Spain, Holland—is their fate to be absorption into a stronger empire? and if so, into which, and for how long? The epithet "cockpit of Europe" is one of warning to other continents.

We are permitted to identify Germany with the dominating policy of Europe because it is setting the pace, assuming the role of fencing master and armorer to sister states (and shamelessly supplies them with weapons, money and tutors to carry on the strife); and because it so successfully combines medieval feudalism, dynastic government and state church with the most advanced science and knowledge in the arts. Hence we find chancellors and reigning emperors alike claiming the usual kingly commission from Deity, the favor of the Almighty, but at the same time making open treaties with one set of powers, secret treaties with another set, and, as if in distrust of all such allies and auxiliaries, providing also the heaviest battalions and best artillery.

How unfortunate, in one sense, is the situation of the African continent in not being permitted to receive the blessings of European civilization without its attendant curses. How much better it would have been to have consolidated the whole into one, or at most two, great commonwealths with a single republican form of government, one standard of loyalty, one language, religious toleration, common jurisprudence, freedom of internal commerce, facile postal and personal intercourse, uniform measures and coinage; instead of the partition into so many reproductions of European differences of flags, creeds, politics, customs, usages, speech, each with its patch of shore front and a vast tract of hinterland to be fortified, defended and jealously watched in perpetuity. It is as if by inoculation the pest virus were poured into youthful arteries. The picturesque old cradle of Mediterranean civilization, now lying isolated from, and yet so close to, the barbaric types, deserved some nobler treatment from the enlightened powers than this selfish spoliation. The opportunity to dedicate deliberately one-quarter of the globe to peace and culture apparently has passed forever.

The dream of a peaceful consolidation of nations—a political millennium—is quite old. Fortunately there are other potent forces at work making for peace. Good will and good neighborship are also inherent emotions. Among these may be reckoned the comity of nations, perhaps also religious propaganda, foreign trade and intercommunication. The late Secretary Blaine set a notable example of the peacemaking impulse when he addressed his eloquent words to the convened representatives of American republics, counseling unification of policies, arbitration of disputes between themselves, and urging again the Fathers' doctrine of "America for Americans." This condensed motto is frequently misunderstood as implying a sort of hostile coalition against Europe calling for a hostile coalition by Europe. It is simply a forecasting desire not to be embroiled in European neighborhood disputes about boundaries, dynasties, creeds, alliances, easement rights to ports, etc., from which America can keep aloof and should be encouraged to do. That invitation, for obvious reasons, omitted the Dominion of Canada. In any future conference it is to be hoped Canadians will see their way clear to participate, in this, as in other prerogatives of self-government, as they have a joint interest in the welfare of North America politically, scientifically and economically.

That the international comity, and if you please the jubilee features, of the year may not be neglected (in which, however, science is thrust far in the background), as an American response to the very hospitable suggestion of Prof. Dicey—probably drafted before the failure of the general arbitration treaty—of a common citizenship for the people of Great Britain, her colonies and offshoots, the United States being specially included, let us say: Unworkable though it be, it is received as an expression of good-will. I venture to offer instead the counter-proposition that we might have with Canada a Zollverein treaty abolishing fortifications, fleets and custom houses along the four thousand mile frontier, letting the tariff revenues be collected at the seaports. Reciprocity of language, traditions, laws, coinage, metrical systems, postage and railroad conveniences we have. By a larger interchange of merchandise and ideas, together with the freest intercourse, the benefits to be derived by both parties are so great that any sacrifice on either side would be insignificant, temporary and easily borne.

Modern warfare is becoming more and more a contest of ingenuity and material resources. Numbers or physique of combatants count for less, and even personal prowess is of less importance. Craft in strategical maneuvers remains as of old. Machines, explosives, transport, commissariat, surgical skill and adjustment of knapsack and accouterments are now paramount. Success depends also on industrial production and intellectual power. National debts, formerly supposed to be aids to peace, have become incentives to war; financiers often find a joint interest with diplomats, purveyors and soldiers, in fomenting or permitting wars to go near the point of danger for dynasties and capital. How to escape from the meshes of this combination is one of the most portentous and baffling of problems of politico-economic science. Following the analogy of guaranty and insurance corporations, it might be well for Europeans to invite proposals from the house of Rothschilds and its affiliations for a stipulated sum for which they will guaranty peace between the several members in lieu of the present onerous exactions of war loans. The financing of governments has become so large a vested industry that it demands the right to live, like some other institutions we shall have occasion to discuss, and society can neither get along comfortably with them nor extinguish them without violence. Let there be started a rumor of an invasion, blockade, or a vote for new ships and arms, by one of the number, the cabinets of Europe are in instant trepidation. The legislative assemblies at once catch the craze—up go the budgets,

* An address before the Section of Social and Economic Science of the American Association for the Advancement of Science, August, 1897. Mr. Colburn is vice-president and chairman of this section.

out go the contracts for munitions and war loans and then fluctuation in the bourses. Somebody presently discovers it was a fictitious, exaggerated alarm, and the agitation subsides, but the taxes remain just the same.

In Mulhall's recent work, "Industry and Wealth of Nations," are the figures of the national debts of Europe with an attempt to segregate that portion incurred for railroad and public works which latter are in many cases part of the military regime. The figures are impressive, but fall far short of expressing the total money cost of armament, to say nothing of the loss of public and social morale. The burden of industry is thrown upon the children and aged women, increasing the hours of labor and lowering the scale of living.

With a due sense of humiliation, we must confess that no single remedy can be found for this unhappy tangle of affairs. Parliaments, by their constitution, represent the opinions of ministerial governments, and are not themselves exempt from war fright. It is a common trick of falling ministries to strengthen their hold on power by resort to menaces and scares. The presence of one unclouded, undaunted mind at the time of panic of the multitude is a priceless desideratum; it is as cheering as the advent of a cool, competent surgeon into a room full of hysterical bystanders around a prostrate patient. Presence of mind, ridicule, satire, caricature and especially comic cartoons are more likely antidotes than argument. The disease is in good part psychic and the remedy must be of the same kind.

Again, therefore, we may say science, including its socio-economic branches, is our best hope for peace and disarmament. Among the suggestions containing more or less of promise, the following are worth mentioning:

(a) The Swedish Prof. Nobel, who accumulated an immense fortune from his nitro-glycerine inventions, has left a large fund to promote the extinction of war by making it so deadly that nations will be afraid to resort to it. Evidently when commanding generals are themselves brought within the range of unseen, and practically irresistible, dangers, they will not be so eager to seek this method of promotion. The stoutest heart quails before a stream of electricity, hot steam, asphyxiating gas or explosives rained from an air ship.

(b) Soldier and civilian are alike interested in maintaining a high standard of health and efficiency, the former having more depending on his doing so. Selected on account of his physique, the soldier should have more than the average intelligence, and if the army regulations or the instruction of the superior officers teach him how to care for himself, to moderate his passions, and endure privations, it will be a small compensation for his detachment from the industrial ranks. Sanitary and personal hygiene are of the utmost importance to the perpetuity of armies, nations and races.

(c) Continuance of the diplomatic methods, cumbrous as they are, must be assumed, although their function is becoming dimmer in the presence of telegraphs, telephones, newspapers and popular participation in national councils. Diplomacy has been at all times under suspicion of insincerity and deceit; but it has the great merit of defining in language the grievances and causes of war, which gives time for passions to cool. Armies are now massed while diplomacy is getting ready; collision comes before the causes can be stated.

(d) Courts of conciliation are an improvement in diplomacy in that they also give time for passions to subside. They do not, however, prevent armament; and armaments are ipso facto provocative of hostilities. They will still be needed as against non-arbitrating parties. The binding force of treaties, not always scrupulously observed, is being weakened by the example of conspicuous breaches. Great Britain and the United States may creditably vie with each other in setting the world an example of this mode of preventing and settling disputes.

(e) To the above, I would fain offer a further suggestion aimed at those who have the responsibility of deciding upon war or peace. The actual ruler, whether it be a parliamentary body, or a President or Chief Secretary, King or Chief Minister, Kaiser or Chancellor, Sultan or Vizier, should be required to obtain the sanction of some deliberative body, not of his own creation or selection. In addition, every such officer should be required by fundamental law to surrender his office, authority and emoluments into the hands of such an assembly, at intervals diminishing progressively with the duration of his reign; such council or parliament to be at full liberty to restore it, further limit it, or to confer it upon a successor. Such a check upon the inebriety of power and incident flattery is needed as a safeguard against aberration of intellect or perversion of moral balance. The temptation and strain upon the faculties of one who is the fountain of honors and promotions ought not to be imposed without some such restraint. The tendency to hero worship is truly a psychological taint, pregnant with dangers enough in the populace and positively ruinous when reflected on a single mind not chosen for robustness.

In this momentous struggle of medieval types against popular forms of government in continental Europe, occupied by three millions of armed men, and seven to ten millions more subject to call, the Britons and Americans jointly owe a duty to the cause of civilization and peace, not to be swayed into the same mad folly.

(To be continued.)

A SKELETON FACTORY.*

ONE day I saw a funeral cortège leave La Roquette (the Newgate of Paris). I followed it to the cemetery of Les Champs des Navets, Ivry, and found that it was that of an Anarchist who had just paid the last penalty for his misdeeds. The rude coffin and few attendant officials reached the place of burial; the priest read the service for the dead beside the open grave, which was quickly filled in, but only the coffin was buried, for, as I afterward learned, the body was sent to the schools for dissection. It is the merciful custom in France to deliver the bodies of criminals to their relatives and friends, but when unclaimed they are sent to the dissecting pavilions for the use of medical students, after a mock funeral such as I had witnessed. Ultimately the skeletons find a place in the Anthropological Museum, where they are duly classed and labeled, so that the public, or rather the student, can study the peculiarities of criminal anatomy. Once I had obtained a clew, I quickly discovered the beginning and the end of skeletons; but the intermediate stages in which a body is stripped of flesh, muscles, nerves and tissues, and becomes transformed into a mere primal osteological structure, was still a mystery. Medical men, students, hospital officials and curators of museums were, I found, profoundly ignorant when questioned on the subject of the preparation of skeletons, but one and all unanimously repudiated the existence of a skeleton factory. It was useless to suggest that there must be a place where by some process the flesh was removed, the bones whitened and properly put together by skilled hands, as we see them in museums and studios. That this was done they admitted, with a shrug of the shoulders, but the where and the how no one would reveal.

At last, however, I found the place I wanted, and after many repulses, succeeded in getting the information required, and also in obtaining permission for an artist to make some sketches. I learned that dissection in the hospitals is not allowed. All bodies unclaimed after a certain time are sent to the dissecting pavilions of the medical schools for the use and instruction of the students, and when finished with there, they are conveyed to a place, the name and locality of which I am not at liberty to divulge. Here the head, trunk, and limbs are cleared entirely of flesh, the bones bleached and afterward treated to a course of preservatives, and finally put together by skilled anatomists. These various processes take twelve months. The factory is under government supervision. The proprietor is a rich man, the business being his sole monopoly. In addition to his place in Paris, he has two branches in London and one in New York, and a separate department for stuffing and skeletonizing animals and birds. The bodies of criminals are sent from the dissecting schools to the factory, and also many specimen bodies of different races sent home by travelers—decomposition having been first arrested by chemical preparations (and injections—are received and here prepared for the anthropological museums in different parts of the world. As soon as the bodies, heads or limbs, as the case may be, reach the factory, they are placed in tanks filled with water and phenic acid, which is continually changed. They are afterward boiled in strong soda water, and again immersed in the tanks. This first stage occupies several months, and the details are far too grewsome to describe. The chemicals used in this process, and also for whitening and preserving the bones, are trade secrets.

Let us visit the stockrooms. Here are shelves full of skulls of all sizes, shapes, and races, some which, by accident, or in the interest of science, have been broken into pieces and neatly put together again with brass wires; drawers full of minute bones, and vast heaps of ribs and larger bones, mysteriously lettered and numbered. In the next room workmen are engaged in piercing the bones and preparing them for the wirers. We will pass through the laboratory and the warehouse—where we see stacks of wire of various thicknesses, springs of all kinds and sizes, stands for mounting the skeletons, and all the tools employed in putting them together—to the workrooms where the finer part of the work is done. Here the dry, fossil-like bones are united to their component parts. Some workmen are engaged in putting together hands, others feet, while several are employed in repairing skulls or fastening springs to various parts to render them movable (or otherwise, according to the purpose for which they are intended and ordered. The completed limbs and skulls are then carried into an adjoining apartment, where the whole skeleton is put together, and finally mounted on a stand or attached to an iron rod, while others have a ring inserted into the skull, by which they may be suspended. From this department they are sent to the packing room and carefully boxed and dispatched to their destination, while others are placed in stock for selection by intending purchasers.

* M. Dinorben Griffith, in Pearson's Magazine.

UNITED STATES CAVIAR IN EUROPE.*

AFTER a careful investigation of the matter, based chiefly upon information received from a firm of this city which imports about 70 per cent. of the caviar entering Germany from the United States, I would express the opinion that there exists a growing and profitable market for this article in this country, as well as in other countries of Europe.

The first importation of the United States caviar into Hamburg was made twenty-nine years ago (in 1867). The shipment consisted of from 20 to 30 kegs of 135 pounds each, the price paid in America by the importers being 2 cents per pound. The caviar came from the Delaware River, from which locality comes 50 per cent. of all the United States caviar now imported here. Four thousand kegs of about 140 pounds net each might be given as the total quantity. Both lake and river caviar are brought to this country, chiefly from the Delaware River, Georgetown, D. C., Chesapeake Bay, the Fraser and Columbia rivers, the Great Lakes, and the Lake of the Woods. Lake Michigan has been entirely fished out. The supply from Lake Huron and Lake Erie has grown quite limited, while that from Lake Superior remains good. The largest quantity comes from the Lake of the Woods. Lake caviar is preferred to that from the rivers, on account of its larger roe, the latter being small and black in the river caviar.

Nearly half of the importations of United States caviar is consumed in the cheap restaurants of Berlin; three-fourths of the other half goes to Austria, and the rest to Italy and other European countries. The importations are increasing, because the article commands a better price here than in the United States and because the supplies of the Elbe and Vistula are decreasing each year. Competition with Russia is possible on account of prices and with Germany on account of the growing scarcity of the native product, as above alluded to, and the larger roe of the American caviar. Holland ships a little caviar to Germany—about 500 pounds annually; the quality, however, is poor.

Elbe caviar sells here for about 3 marks (72 cents) per half kilogramme (1·02 pounds); Russian sells for about 10 marks ($2.38) per half kilogramme for good medium quality, the highest grade bringing 13 to 14 marks ($3.09 to $3.33) per half kilogramme. These figures for the Russian caviar are the prices in the free harbor, that is, without duty of 75 pfennigs (17¾ cents) per half kilogramme.

Delaware caviar, I am told, cost at home, in 1893, from $25 to $28 per keg, and, in 1896, as high as $46 per keg. The prices this season are likely to equal those of last year.

Lake caviar was sold last year in the United States as high as $60 per keg of about 140 pounds net. While I cannot vouch for the statement, I have been informed by the leading firm here that the highest amount ever received in this market for lake caviar was 2⅛ marks (50½ cents) per half kilogramme without the duty. This price includes, however, an apparent loss in weight of 10 per cent. as the difference between American and German pounds, the freight from the lakes to Hamburg, cold storage, brokerage, commissions, etc., and 10 per cent. allowance for spoiled goods.

United States caviar is sold here by German pounds net, and, strange to remark, is salted at home with German salt, which is sent there for the purpose. It is claimed that it possesses preservative properties superior to those of American salt. Even the caviar from as far west as the Columbia River is treated with German salt.

The freight from New York to Hamburg is about 2 marks (47½ cents) per keg, or 4 marks (95 cents) if shipped in refrigerators. The high freight from the lakes to New York is an unfortunate expense to the export trade in this article. Another serious disadvantage to our product is the equal specific duty of 75 pfenigs (17¾ cents) paid by Russian and American caviar on entering Germany, which operates unfavorably, because our article is so much cheaper.

With a view to increasing the popularity of United States cavier in this and other European markets, which an effort should be made to win, it is respectfully suggested to our dealers and exporters that not less than 14 pounds of salt should be used in preserving 100 pounds of roe, to which about 2 pounds of preservative salt should be added. Under such treatment, it is confidently claimed that the caviar could not possibly spoil. The Columbia River packers who now use pine wood kegs, which are too light, should substitute those made of oak. I shall be most happy to do anything in my power to place our exporters in communication with reliable parties in this city handling United States caviar. W. HENRY ROBERTSON, Consul.

Hamburg, February 27, 1897.

* United States Consular Report.

VILLAGE INDUSTRIES OF RUSSIA.

THE most noticeable feature of Russia, as distinguished from western European industry, is the more intimate connection of the former with rural economy. This means that to this day, at any rate in the majority of cases, the Russian factory hand does not abandon husbandry in his own village, but strives to maintain his connection with the land, and that trades in Russia are developed to a far greater extent in the villages than in the towns. According to a report issued from the Chancery of the Committee of Ministers, St. Petersburg, in ancient Russia the town still retained comparatively more importance for industry. In the Moscow period, however, with the strength of the power of the government, and the decline of the autonomy of the towns, trades began to be concentrated in the villages, whence craftsmen began to visit the towns only for temporary engagements on hire, or to execute the Tsar's tasks as a duty. The causes of the concentration of handicrafts in the villages were many. Town life was very feebly developed, the towns themselves differed little from villages, and in the village, husbandry alone did not always and everywhere afford a living to the peasantry, as is the case also at the present time. On the other hand, the prolonged winters, especially in central and northern Russia, left a great deal of spare time. In this village industry, or, as it is called, "koostar" industry, besides the head of the family, the other members, both men and women, take part in the work, and, not unfrequently, children of seven to ten years of age. In some trades, particularly in those of lace making and weaving, women even take the chief part. Village industries, in the course of their long history, have elaborated peculiar technical methods of their own, and a certain division of labor. Thus, for example, one part of the work is performed by children, another by adults, and a third by the aged; or in one village, one part of the article is made, in another neighboring village, another part, while in a third, the parts are put together, and in a fourth, painted. Under these conditions, koostar industry has continued to develop, notwithstanding even that the cheapness of peasant labor, and of materials, and the immense competition resulting from these causes, and the difficulty of sale, have considerably reduced the prices for these goods. There are now in all over fifty distinct kinds of village or koostar trades. Without dwelling upon their description, it will be only necessary to say that, in accordance with local conditions, the village artisans or koostars are employed above all in the manufacture of articles from wood. There are as many as 80,000 households employed in making baskets, mats, wheels, carts, buttons, spoons, and even furniture and concertinas. The northern flax growing districts manufacture linen tablecloths and towels. The central districts take orders from the manufacturers for weaving the commoner cotton goods. More than 150,000 men are occupied in the preparation of leather. As many as 19,000 peasant households are employed in the manufacture of hardware. Particularly well known in the last respect are the villages of Pavlovo, Vorsma and Bezvodnoe, in the government of Nijni-Novgorod. Together with the extensive koostar districts adjoining them, these villages earn very considerable sums each year, and Pavlovo has, on account of the excellent workmanship of its cutlery, gained the name of the Russian Sheffield. If to the above mentioned industries be added the "samovar" industry in the Toola government, the painting of images on wood, lace making, and the manufacture of toys, this will complete the enumeration of the principal branches of koostar production. It is impossible to arrive at the total value of the production of such goods in Rus-

sia, from the absence of any reliable data. An equal uncertainty exists as to the exact number of persons employed in koostar industries. Some investigators fix it at 6,000,000, or four times that of the factory hands and miners. In any case, even these approximate figures are a clear indication of the importance of koostar in Russia. In some branches of industry, it stands higher, in regard to the value of the output, than that of the factories. For example, in the leather trade, the production of the manufactories is estimated at from £3,700,000 to £4,200,000, while that of the koostars reaches £5,800,000. The question as to whether koostar industry in Russia is doomed to be absorbed by manufacturing industry on a large scale is a moot one. In that country the solution of this question depends not only upon the advantages of production on a large scale over small production, in the sense of the application of improved methods, cheapening the work of machinery, etc., but also upon the need of the koostar for agricultural earnings; for so long as these earnings possess for the peasant sufficient importance for him to regard the koostar industry as a supplementary one, so long will he be in a position to reduce the price of the articles he makes almost to that of the material, and not to aspire to such a wage as would secure his independent existence. Taking, however, everything into consideration, the Russian koostar industry is stated to possess many elements for a prolonged existence and for considerable development. The most important measure for the improvement of koostar productions, and of the economic conditions of the koostars themselves, must be regarded as the extension among them of technical knowledge, of credit and of stores for the sale of koostar goods in the great towns, etc. These questions have lately been receiving the most careful attention from the government and the rural authorities (Zemstvos). There is a remarkable collection of the products of koostar industry in the St. Petersburg Agricultural Museum, and koostar exhibitions are organized in other parts of Russia.—Journal of the Society of Arts.

THE ASHANTEES IN THE ZOOLOGICAL GARDENS AT VIENNA.

THE zoological gardens of Vienna have lately been visited by a troupe of negroes from the territory between the Gold Coast and the Ashantee country. By a stretch of the real meaning of the name, these are commonly designated Ashantee negroes.

It appears that on a former visit the negroes were so favorably impressed by Vienna and its inhabitants that they have now returned in increased numbers. They are indeed treated with such regard and sympathy that their sojourn on the banks of the Danube becomes a thoroughly enjoyable time for them. The colored men and women, and particularly the little negro children, have made themselves quite favorites with the visitors of the zoological gardens, whose number amounts to twenty or twenty-five thousand on holidays.

These Ashantees constitute a very interesting subject for study in ethnology, and all the more so because their general conduct and their performances are natural and true, free from those artifices calculated to produce sensation, which so often deteriorate similar shows.

The negroes, as we find them in Vienna, do not by any means represent the lowest and utterly uncivilized class of Africans. For centuries Portuguese, Dutchmen, English and French have traded on their shores, and have built forts and colonies. Missions, too, have been carried on, and some of the Vienna guests are Christians, and even speak a very broken English, but the mass of them have retained their primitive language and customs in their full originality. They show clearly how slow the development of culture is in those African territories.

AN ASHANTEE KITCHEN.

The Ashantees are accommodated in the gardens in very cleanly huts of native construction. Each hut gives shelter to one family. The whole troupe is under the rule of a chief, who is responsible for their conduct to the English consul. He carries a staff, which he has, however, no occasion to use, as his people obey him instantly on the least sign from him. He watches his people jealously for the keeping of good order and morals, and is assisted in this task by the married men and women.

Ashantee customs make married women of girls from twelve to thirteen years of age. The women, who are not, as a rule, long lived, have neither beauty nor grace. They carry their children upon their backs, in consequence of which custom they become fitted with a natural support in the form of a cushion of fat, which has been connected by analogy with the similar decorations of the burden bearer of the desert—the camel.

These negro women are very cleanly, and the picturesque folds which constitute their dress are always of absolute purity. Among the children some charming creatures are found. The little boys and girls show a remarkably gay and peaceful disposition, and behave exceedingly well in the school, which is held by a negro schoolmaster, and where they do their writing in kneeling posture. In their spare time they amuse themselves in various ways, very much like white children. Some of the men follow various occupations as artisans, and, in spite of their primitive tools, turn out very creditable products. Thus some are smiths, others weave mats and baskets, some are boat builders, and even goldsmiths. One of our illustrations shows a man spooling wool. His device for doing this work is very ingenious. In one hand he holds the spool, a rotating stick supported at one end in his hand and at the other on the ground. We see that he has even taken the trouble and had the good sense to furnish this part of the apparatus with a small fly wheel. The second part of the apparatus shows how simple things may serve for good ends. Here a bottle makes a very good bearing for the rotating reel from which the wool is wound by giving it an occasional impulse.

The women, carrying their children, are employed in the kitchen, cooking the meals on primitive fireplaces. The yam root, which forms the chief food in their native country, is supplanted during their stay in Europe by the potato, which is mashed and served in balls. The kitchens are not particularly appetizing, but one step they have already advanced, for enameled tin pots have come into use. Our illustration shows a group of women engaged in various kinds of kitchen work. We see one churning, two others peeling potatoes, while a third, smoking a pipe, and carrying a child on her back, is apparently taking a rest.

The chief attraction, however, of this negro colony is found in the original performances of the Ashantees, which include singing and dancing, a procession led by the chief, and battle scenes. In the singing and the playing of their musical instruments these negroes show an untiring zeal. Most of them belong to the musician caste, which in Africa play a similar part as the gypsies do in Hungary, except that the services of the latter are required only on joyful occasions, while the former do not by any means restrict their productions to such times. They make their music part of their religious ceremonies, and consequently resort to it on all occasions. Their dances, too, are religious rites. One of them, if once begun, must be continued till nightfall, no matter how early in the day it may have

MAN SPOOLING WOOL.

commenced. Our illustration represents some of these blacks engaged in the performance of one of their dances, known as the handkerchief dance.

It is in the evening, when the day's work is over, that the good time for the negroes sets in. Attentions, which are not wanting by day, are now lavishly poured on them. Men and women, but particularly children, are asked to partake of the evening meal with the white visitors. It is a comic sight to find the majority of tables of the park restaurant occupied by a motley company of black and white, to see richly dressed ladies and gentlemen joking playfully with little colored children. The older children accept these attentions with simple grace, and enjoy greatly the privilege of eating with knife and fork.

This visit of the Ashantees has proved a help in need to the zoological gardens at Vienna, for affairs had taken a very bad turn, and a total breakdown was feared, while under the present circumstances a promising turn of the tide has set in, which, it is hoped, will enable the institution to live through the apparently hard times.

Our illustrations are taken from Illustrirte Zeitung.

THE BRITISH ASSOCIATION — ADDRESS IN GEOGRAPHY.

THE address in Section E was delivered by Dr. J. Scott Keltie, Sec. R.G.S., who, after some preliminary remarks, said: There is a prevalent belief that geographers have nothing more to learn in Europe—that that old continent has been thoroughly explored. It is true that nearly every country in Europe has been, or is being, trigonometrically surveyed. Except some parts of the Balkan Peninsula and north of Russia, the topography of the continent has been accurately mapped on scales and by methods sufficient at least for the purposes of the geographer. Yet there are districts in the Balkan Peninsula—for example, Albania—which are as vaguely known as Central Africa. But it is a delusion to think that because a country has been fully mapped the occupation of the geographer is gone. It is only when a region at large is adequately mapped that the work of geographical research begins. The student, with a satisfactory map of a definite district as his guide, will find on the spot abundant occupation in working out its geographical details, the changes which have taken place in its topography, and the bearing of its varied features upon its history, its inhabitants, its industries. This kind of work has been in progress in Germany for over ten years, under the auspices of the Central Commission for the Scientific Geography (Landeskunde) of Germany, with its seat at Stuttgart. Under the collective title of "Forschungen zur Deutschen Landes und Volkskunde," a long series of monographs by specialists has been published, dealing in minute detail with one or more aspects of a limited district. Thus we have such memoirs as "The Plain of the Upper Rhine and its Neighboring Mountains," by Dr. Richard Lepsius; "The Towns of the North German Plain in Relation to the Configuration of the Ground," by Dr. Hahn; "The Munich Basin: a Contribution to the Physical Geography of Southern Bavaria," by C. Gruber; "The Mecklenburg Ridges and their Relation to the Ice Age," by Dr. E. Geinitz; "The Influence of the Mountains on the Climate of Central Germany," by R. Assmann; "The Distribution and Origin of the Germans in Silesia," by Dr. K. Weinhold; "Mountain Structure and Surface Configuration of Saxon Switzerland," by Dr. A. Hettner; "The Erzgebirge: an Orometric-Anthropogeographical Study," by Dr. J. Burgkhardt; "The Thuringian Forest and its Surroundings," by Dr. H. Pröscholdt, and so forth. There is thus an inexhaustible field for scientific geography in its most comprehensive sense, a series of problems which may take generations to work out. In a less systematic way we have similar monographs by French geographers. One or two attempts, mainly by teachers, have been made in England to do similar work, but the impression generally produced is that the authors have not been well equipped for the task. I am glad to say that in England the Royal Geographical Society has initiated a movement for working out in a systematic fashion what one may call the regional geography of the British Islands on the basis of the one inch maps of the Ordnance Survey. It is a strange thing that the geography of the mother country has never yet been systematically worked out. Taking the sheets of the Ordnance Survey map as a basis, it is proposed that each district should be thoroughly investigated, and a complete memoir of moderate dimensions systematically compiled to accompany the sheet, in the same way that each sheet of the Geological Survey map has its printed text. It is a stupendous undertaking that would involve many years' work, and the results of which, when complete, would fill many volumes. But it is worth doing; it would furnish the material for an exact and trustworthy account of the geography of Britain on any scale, and would be invaluable to the historian, as well as to others dealing with subjects having any relation to the past and present geography of the land. The librarian of the society, Dr. H. R. Mill, has begun operations on a limited area in Sussex. When he has completed this initial memoir, it will be for the society to decide whether it can continue the enterprise or whether it will succeed in persuading the government to take the matter up. I refer to work of this kind mainly to indicate what, in my conception, are some of the problems of the future which geography has to face, even in fully surveyed countries. Even were the enterprise referred to carried out, there would be room enough for special researches in particular districts. But while there is an inexhaustible field in the future for geographical work in the direction I have indicated, there is no doubt that much still remains to be done in the way of exploring the unknown, or little known, regions of the globe. Let us briefly refer to the problems remaining to be solved in this direction. Turning to the continent of Asia, we find that immense progress has been made during the past 60 years. In the presidential address given 60 years ago, already referred to, Mr. Hamilton says of Asia: "We have only a very general knowledge of the geographical character of the Burman, Chinese and Japanese empires; the innumerable islands of the latter are still, except occasionally, inaccessible to European navigators. Geographers hardly venture on the most loose description of Tibet, Mongolia, or Chinese Tartary, Siam, and Cochin China." Since then the survey of India—one of the greatest enterprises undertaken by any state—has been completed, and is being rapidly extended over Burma. But I need not remind you in detail of the vast changes that have taken place in Asia during these years, and the immense additions that have been made to our knowledge of its geography. Exploring activity in Asia is not likely to cease, though it is not to be expected that its inhospitable center will ever be so carefully mapped as have been the mountains of Switzerland. The most important desiderata, so far as pioneer exploration in Asia is concerned, may be said to be confined to two regions.* In Southern and Central Arabia there are tracts which are entirely unexplored. It is probable that this unexplored region is in the main a sandy desert. At the same time, it is, in the south at least, fringed by a border of mountains whose slopes are capable of rich cultivation, and whose summits the late Mr. Theodore Bent found, on his last and fatal journey, to be covered with snow. In exploration, as in other directions, it is the unexpected that happens; and if any traveler cared to face the difficulties—physical, political and religious—which might be met with in Southern and Central Arabia, he might be able to tell the world a surprising story. The other region in Asia where real pioneer work still remains to be done is Tibet and the mountainous districts bordering it on the north and east. Lines of exploration have in recent years been run across Tibet by Russian explorers like Prejevalsky, by Rockhill, Prince Henry of Orleans and Bonvalot, by Bower, Littledale, Welby, and Malcolm. From the results obtained by these explorers we have formed a fair idea of this, the most extensive, the highest, and

THE HANDKERCHIEF DANCE.

THE MOST INHOSPITABLE PLATEAU IN THE WORLD.

A few more lines run in well-selected directions would probably supply geography with nearly all she wants to learn about such a region, though more minute exploration would probably furnish interesting details as to its geological history. The region lying to the north of the Himalayan range and to the south of the parallel of Lhasa is almost a blank on the map, and there is ample room here for the enterprising pioneer. The forbidden city of Lhasa is at present the goal of several adventurers, though, as a matter of fact, we cannot have much to learn in addition to what has been revealed in the interesting narrative of the native Indian traveler, Chandra Das. The magnificent mountain region on the north and east of Tibet furnishes a splendid field for the enterprising explorer. Mrs. Bishop recently approached it from the east, through Szechuen, and her description of the romantic scenery and the interesting non-Mongolian inhabitants leaves us with a strong desire to learn more. On the southeast of Tibet is the remarkable mountainous region, consisting of a series of lofty parallel chains, through which run the upper waters of the Yangtse, the Mekong, the

* For part of what follows with reference to Asia, I am indebted to a valuable memorandum on the subject drawn by the late Mr. Ney Elias.

Salwin, and the Irawady. This last named river, recent exploration has shown, probably does not reach far into the range. But it will be seen by a glance at a map that the upper waters of the other rivers are carried far into the heart of the mountains. But these upper river courses are entirely conjectural, and have given rise to much controversy. There is plenty of work here for the explorer, though the difficulties, physical and political, are great. But besides these great unexplored regions, there are many blanks to be filled up in other parts of Asia, and regions which, though known in a general way, would well repay careful examination. There is the mountain tract between the upper Zarafshan River and the middle course of the Sarkhab tributary of the Oxus, and the country lying between that and the Oxus. There is the great Takla-Makan Desert in Chinese or Eastern Turkistan, part of which has recently been explored by Russian expeditions, and by that young and indefatigable Swedish traveler, Dr. Sven Hedin. It is now one of the most forbidding deserts to be found anywhere; but it deserves careful examination, as there are evidences of its once having been inhabited, and that at no very remote period. It is almost surrounded by the Tarim, and on its eastern edge lies Lob-nor, the remarkable changes in which have been the subject of recent investigation. As readers of Dr. Nansen's "Voyage of the Fram" will remember, the Siberian coast is most imperfectly mapped; of course, it is a difficult task, but it is one to which the Russian government ought to be equal. China has on paper the appearance of being fairly well mapped; but, as a matter of fact, our knowledge of its mountain ranges and of its great river courses is, to a large extent, extremely vague. All this awaits careful survey. In Northeastern Manchuria and in many parts of Mongolia there are still blanks to be filled up, and mountain and river systems to be surveyed. In the Malay Peninsula, and in the great array of islands in the east and southeast of Asia—Sumatra, Borneo, the Philippines—much work still remains to be done. Thus, for the coming century, there will be abundance of work for explorers in Asia. Coming to

THE MAP OF AFRICA,

we find a marvelous transformation during the last sixty years, and mainly during the last forty years, dating from Livingstone's memorable journey across the continent. Though the north of Africa was the home of one of the oldest civilizations, and though on the shores of the Mediterranean Phenicians, Carthaginians, Greeks, and Romans were at work for centuries, it has only been within the memory of many of us that the center of the continent, from the Sahara to the confines of Cape Colony, has ceased to be an unexplored blank. This blank has been filled up with bewildering rapidity. Great rivers and lakes and mountains have been laid down in their main features, and the whole continent, with a few uninportant exceptions, has been parceled out among the powers of Europe. But much still remains to be done ere we can form an adequate conception of what is in some respects the most interesting and the most intractable of the continents. Many curious problems still remain to be solved. The pioneer work of exploration has to a large extent been accomplished; lines have been run in all directions; the main features have been blocked out. But between these lines the broad meshes remain to be filled in, and to do this will require many years of careful exploration. However, there still remain one or two regions that afford scope for the adventurous pioneer.

To the south of Abyssinia and to the west and northwest of Lake Rudolf, on to the Upper Nile, is a region of considerable extent, which is still practically unknown. Again, in the Western Sahara there is an extensive area, inhabited mainly by the intractable Tuaregs, into which no one has been able to penetrate, and of which our knowledge is extremely scanty. Even in the Central Sahara there are great areas which have not been traversed, while in the Libyan Desert much remains to be done. These regions are of interest almost solely from the geographical and geological standpoints. But they deserve careful investigation, not only that we may ascertain their actual present condition, but in order, also, that we may try to discover some clews to the past history of this interesting continent. Still, it must be said that the great features of the continent have been so fully mapped during the last half century that what is required now is mainly the filling in of the details. This is a process that requires many hands and special qualifications. All over the continent there are regions which will repay special investigation.

Quite recently an English traveler, Mr. Cowper, found not far from the Tripoli coast miles of magnificent ruins, and much to correct on our maps. If only the obstructiveness of the Turkish officials could be overcome, there is a rich harvest for anyone who will go to work with patience and intelligence. Even the interior of Morocco, and especially the Atlas Mountains, are but little known. The French, both in Tunis and Algeria, are extending our knowledge southward. All the powers who have taken part in the scramble for Africa are doing much to acquire a knowledge of their territories. Germany, especially, deserves praise for the persistent zeal with which she has carried out the exploration of her immense territories in East and West Africa. The men she sends out are unusually well qualified for the work, capable not simply of making a running survey as they proceed, and taking notes on country and people, but of rendering a substantial account of the geology, the fauna, the flora, and the economic conditions. Both in the French and the British spheres good work is also being done, and the map of Africa being gradually filled up. But what we especially want now are men of the type of Dr. J. W. Gregory, whose book on the Great Rift Valley is one of the most valuable contributions to African geography ever made.

If men of this stamp would settle down in regions like that of Mount Ruwenzori, or Lake Rudolf, or the regions about Lakes Bangweolo and Tanganyika, or in the Atlas, or in many other regions that could be named, the gains to scientific geography, as well as to the economical interests of Africa, would be great. An example of work of this kind is seen in the discoveries made by a young biologist trained in geographical observation—Mr. Moore, on Lake Tanganyika. There he found a fauna which seems to afford a key to the past history of the center of the continent, a fauna which, Mr. Moore maintains, is essentially of a soft water type. Mr. Moore, I believe, is inclined to maintain that the ancient connection of this part of Africa with the ocean was not by the west, as Joseph Thomson surmised, but by the north, through the Great Rift Valley of Dr. Gregory; and he strongly advocates the careful examination of Lake Rudolf as the crucial test of his theory. It is to be hoped that he, or some one equally competent, will have an opportunity of carrying out an investigation likely to provide results of the highest importance. I have dwelt thus long on Africa, because it will really be one of the great geographical problems of the coming century. Had it been as suitable as America or Australia, we may be sure it would not have remained so long neglected and despised by the European peoples as it has done. Unfortunately for Africa, just as it has been circumnavigated, and just as Europeans were beginning to settle upon its central portion and trying to make their way into the interior, Columbus and Cabot discovered

A NEW WORLD.

Probably nothing could be more marked than the progress which America has made since its rediscovery 400 years ago, and the stagnation of Africa which has been known to Europe since long before the beginning of history. During these 400 years North America at least has been very thoroughly explored. The two great nations which divide North America between them have their government surveys, which are rapidly mapping the whole continent and investigating its geology, physical geography and its natural resources. I need hardly tell an audience like this of the admirable work done by the survey of Canada under Sir William Logan, Dr. Selwyn, and his successor, Dr. George Dawson; nor should it be forgotten that under the Lands Department much excellent topographical work has been carried out by Captain Deville and his predecessors. Still, though much has been done, much remains to be done. There are large areas which have not as yet even been roughly mapped. Within quite recent years we have had new regions opened to us by the work of Dawson and Ogilvie on the Yukon, by Dr. Bell in the region to the south of Hudson's Bay, by the brothers Tyrrell in the Barren Lands on the west of the same bay, by O'Sullivan beyond the sources of the Ottawa, and by Low in Labrador. But it is no so long since that Dr. Dawson, in reviewing what remains to be done in the Dominion in the way of even pioneer exploration, pointed out that something like a million square miles still remained to be mapped. Apart from the uninhabitable regions of the north, there are, as Dr. Dawson pointed out, considerable areas which might be turned to profitable agricultural and mining account of which we know little, such areas as those which have been recently mapped on the south of Hudson's Bay by Dr. Bell, and beyond the Ottawa by Mr. O'Sullivan. Although the eastern and western provinces have been very fully surveyed, there is a considerable area between the two lying between Lake Superior and Hudson's Bay which seems to have been so far almost untouched. A very great deal has been done for the survey of the rivers and lakes of Canada. I need hardly say that in Canada, as elsewhere in America, there is ample scope for the study of many problems in physical geography—past and present glaciation and the work of glaciers, the origin and regime of lake basins, the erosion of river beds, the oscillation of coast lines.

Happily, both in Canada and the United States, there are many men competent and eager to work out problems of this class, and in the reports of the various surveys, the transactions of American learned societies, in scientific periodicals, in separate publications, a wealth of data has already been accumulated of immense value to the geographer. Every geologist and geographer knows the important work which has been accomplished by the various surveys of the United States, as well as by the various State surveys. The United States coast survey has been at work for more than half a century, mapping not only the coast, but all the navigable rivers. The lake survey has been doing a similar service for the shores of the great lakes of North America. But it is the work of the Geological Survey which is best known to geographers—a survey which is really topographical as well as geological, and which, under such men as Hayden, King and Powell, has produced a series of magnificent maps, diagrams and memoirs, of the highest scientific value and interest. Recently this survey has been placed on a more systematic basis; so that now a scheme for the topographical survey of the whole of the territory of the United States is being carried out. Extensive areas in various parts of the States have been already surveyed on different scales. It is to be hoped that in the future, as in the past, the able men who are employed on this survey work will have opportunities of working out the physiography of particular districts, the past and present geography of which is of advancing scientific interest. Of the complete exploration and mapping of the North American continent we need have no apprehension; it is only a question of time, and it is to be hoped that neither of the governments responsible will allow political exigencies to interfere with what is really a work of national importance. It is when we come to Central and South America that we find ample room for the unofficial explorer. [I am indebted for much of the information relative to South America to a valuable memorandum by Sir Clements R. Markham and Col. G. E. Church.] In Mexico and the Central American states there are considerable areas of which we have little or only the vaguest knowledge. In South America there is really more room now for the pioneer explorer than there is in Central Africa. In recent years the Argentine Republic has shown a laudable zeal in exploring and mapping its immense territories, while a certain amount of good work has also been done by Brazil and Chile. Most of our knowledge of South America is due to the enterprise of European and North American explorers.

Along the great river courses our knowledge is fairly satisfactory, but the immense areas, often densely clad with forests, lying between the rivers are almost entirely unknown. In Patagonia, though a good deal has lately been done by the Argentine government, still, in the country between Punta Arenas and the Rio Negro, we have much to learn; while on the west coast range, with its innumerable fjordlike inlets, its islands and peninsulas, there is a fine field for the geologist and physical geographer. Indeed, throughout the whole range of the Andes systematic exploration is wanted, exploration of the character of the excellent work accomplished by Whymper in the region around Chimborazo. There is an enormous area lying to the east of the Northern Andes, and including their eastern slopes, embracing the eastern half of Ecuador and Colombia, Southern Venezuela, and much of the country lying between that and Northern Bolivia, including many of the upper tributaries of the Amazon and Orinoco, of which our knowledge is of the scantiest. Even the country lying between the Rio Negro and the Atlantic is but little known. There are other great areas, in Brazil and in the Northern Chaco, which have only been partially described, such as the region whence the streams forming the Tapajos and the Paraguay take their rise, in Mato Grosso. A survey and detailed geographical and topographical description of the whole basin of Lake Titicaca is a desideratum. In short, in South America there is a wider and richer field for exploration than in any other continent. But no mere rush through these little-known regions will suffice. The explorer must be able not only to use his sextant and his theodolite, his compass and his chronometer. Any expeditions entering these regions ought to be able to bring back satisfactory information on the geology of the country traversed, and of its fauna and flora, past and present; already the revelations which have been made of the past

GEOGRAPHY OF SOUTH AMERICA

are of the highest interest. We have remains of extinct civilizations to deal with, and although much has been done in this direction, much remains to be done; and in the extensive region already referred to, the physique, the traditions, and the customs of the natives will repay careful investigation. The southern continent of Australia is in the hands of men of the same origin as those who have developed to such a wonderful extent the resources of Canada and the United States, and therefore we look for equally satisfactory results so far as the characteristics of that continent permit. The five colonies which divide among them the three million square miles of the continent have each of them efficient government surveys, which are rapidly mapping their features and investigating their geology. But Australia has a trying economic problem to solve. In none of the colonies is the water supply quite adequate; in all are stretches of desert country of greater or less extent. The center and western half of the continent is covered by a desert more waterless and more repellent than even the Sahara; so far as our present knowledge goes, one-third of the continent is uninhabitable. This desert area has been crossed by explorers, at the expense of great sufferings, in various directions, each with the same dreary tale of almost featureless sandy desert, covered here and there with spinifex and scrub, worse than useless. There are hundreds of thousands of square miles still unknown; but there is no reason to believe that these areas possess any features that differ essentially from those which have been found along the routes that have been explored. There have been one or two well-equipped scientific expeditions in recent years that have collected valuable data with regard to the physical characteristics, the geology and biology of the continent; and it is in this direction that geography should look for the richest results in the future. There remains much to be done before we can arrive at satisfactory conclusions as to the physical history of what is, in some respects, the most remarkable land area on the globe.

Though the surface water supply is so scanty, there is reason to believe that underneath the surface there is an immense store of water. In one or two places in Australia, esepcially in Western Queensland, and in New South Wales, this supply has been tapped with satisfactory results; millions of gallons a day have been obtained by sinking wells. Whether irrigation can ever be introduced on an extensive scale into Australia depends upon the extent and accessibility of the underground water supply, and that is one of the geographical problems of the future in Australia. New Zealand has been fairly well surveyed, though a good deal remains to be done before its magnificent mountain and glacier system is completely known. In the great island of New Guinea both the British and the Germans are opening the interiors of their territories to our knowledge, but the western and much larger portion of the island presents a large field for any explorer who cares to venture into its interior. The marvelous success which has attended Dr. Nansen's daring adventure into the Arctic seas has revived a widespread interest in

POLAR EXPLORATION.

Nansen has almost solved the North Polar problem. That some one will reach the Pole at no distant date is certain. Nansen has shown the way, and the legitimate curiosity of humanity will not rest satisfied till the goal be reached. But Arctic exploration does not end with the attainment of the Pole. Europe has done her share on her own side of the Pole; what about the side which forms the Hinterland of North America, and specially of Canada? To the north of Europe and Asia we have the scattered groups of islands Spitzbergen, Franz Josef Land, Novaya Zemlya and the New Siberian Islands. To the north of America we have an immense archipelago, the actual extent of which is unknown.

Nansen and other Arctic authorities maintain that the next thing to be done is to complete exploration on the American side—to attempt to do for that half of the North Polar region what Nansen has done for the other half. It may be that the islands which fringe the northern shores of the New World are continued far to the north; if so, they would form convenient stages for the work of a well-equipped expedition. It may be that they do not go much farther than we find them on our maps.

Whatever be the case, it is important, in the interest of science, that this section of the Polar area be examined; that as high a latitude as possible be attained; that soundings be made to discover whether the deep ocean extends all round the Pole. It is stated that the gallant Lieut. Peary has organized a scheme of exploring this area which would take several years to accomplish. Let us hope that he will be able to carry out his scheme. Meantime, should Canada look on with indif-

ference? She has attained the standing of a great and prosperous nation. She has shown the most commendable zeal in the exploration of her own immense territory. She has her educational, scientific, and literary institutions, which will compare favorably with those of other countries; her press is of a high order, and she has made the beginnings of a literature and an art of her own. In these respects she is walking in the steps of the mother country. But has Canada not reached a stage when she is in a position to follow the maternal example still further? What has more contributed to render the name of Great Britain illustrious than those great enterprises which for centuries she has sent out from her own shores, not a few of them solely in the interests of science? Such enterprises elevate a nation and form its glory and its pride. Surely Canada has ambitions beyond mere material prosperity, and what better beginning could be made than the equipment of an expedition for the exploration of the seas that lie between her and the Pole? I venture to throw out these suggestions for the consideration of those who have at heart the honor and glory of the great Canadian Dominion. Not only has an interest in Arctic exploration been revived, but in Europe at least an even greater interest has grown up in the exploration of the region around the opposite pole of the earth, of which our knowledge is so scanty.

Since Sir James C. Ross' expedition, which was sent out in the year 1839, almost nothing has been done for Antarctic research. We have here to deal with conditions different from those which surround the North Pole. Instead of an almost landless ocean, it is believed by those who have given special attention to the subject that a continent about the size of Australia covers the South Polar region. But we do not know for certain, and surely, in the interests of our science, it is time we had a fairly adequate idea of what are the real conditions. We want to know what is the extent of that land, what are its glacial conditions, what is the character of its geology, what evidence exists as to its physical and biological conditions in past ages? We know there is one lofty active volcano; are there any others? Moreover, the science of terrestrial magnetism is seriously impeded in its progress because the data in this department from the Antarctic are so scanty. The seas around this continent require to be investigated both as to their depth, their temperature, and their life. We have here, in short, the most extensive unexplored area on the surface of the globe. For the last three or four years the Royal Geographical Society, backed by other British societies, have been attempting to move the home government to equip an adequate expedition to complete the work begun by Ross sixty years ago, and to supplement the great work of the Challenger. But though sympathy has been expressed for Antarctic exploration, and though vague promises have been given of support, the government is afraid to enter upon an enterprise which might involve the services of a few naval officers and men. We need not criticise this attitude. But the Royal Geographical Society has determined not to let the matter rest here. It is now seeking to obtain the support of public-spirited men for an Antarctic expedition under its own auspices. It is felt that Antarctic exploration is peculiarly the work of England, and that if an expedition is undertaken, it will receive substantial support from the great Australasian colonies, which have so much to gain from a knowledge of the physical condition of a region lying at their own doors, and probably having a serious influence on their climatological conditions. Here, then, is one of the greatest geographical problems of the future, the solution of which should be entered upon without further delay. It may be mentioned that a small and well-equipped Belgian expedition has already started, mainly to carry out deep sea research around

THE SOUTH POLAR AREA.

But our science has to deal not only with the lands of the globe; its sphere is the whole of the surface of the earth, and all that is thereon, so far, at least, as distribution is concerned. The department of oceanography is a comparatively new creation; indeed, it may be said to have come definitely into being with the famous voyage of the Challenger. There had been expeditions for ocean investigation before that, but on a very limited scale. It has only been through the results obtained by the Challenger, supplemented by those of expeditions that have examined more limited areas, that we have been able to obtain an approximate conception of the conditions which prevail throughout the various ocean depths—conditions of movement, of temperature, of salinity, of life. We have only a general idea of the contours of the ocean bed, and of the composition of the sediment which covers that bed. The extent of the knowledge thus acquired may be gaged from the fact that it occupies a considerable space in the fifty quarto volumes—the "Challenger Publications," which it took Dr. John Murray twenty years to bring out. But that great undertaking has only, as it were, laid down the general features of the oceanic world. There is plenty of room for further research in this direction. Our own surveying ships, which are constantly at work all over the world, do a certain amount of oceanic work, apart from mere surveying of coasts, and islands, and shoals. In 1895 one of these found in the South Pacific soundings deeper by 500 fathoms than the deepest on record, that found twenty years earlier by the Tuscarora to the northeast of Japan. The deepest of these new soundings was 5,155 fathoms. In the interests of science, as well as of cable laying, it is desirable that our surveying ships should be encouraged to carry out work of this kind more systematically than they do at present. This could surely be arranged without interfering with their regular work. We want many more observations than we now have, not only on ocean depths, but on the nature of the ocean bed, before we can have a satisfactory map of this hidden portion of the earth's surface, and form satisfactory conclusions as to the past relations of the ocean bed with what is now dry land. I believe the position maintained by geologists, that from the remote period when the great folds of the earth were formed, the present relations between the great land masses and the great oceans have been essentially the same; that there have no doubt been great changes, but that these have been within such limits as not to materially affect their relations as a whole. This is a problem which further oceanic research would go a long way to elucidate. That striking changes are going on at the present day, and have been going on within the human period, cannot be doubted. Some coast lines are rising; others are falling. Prof. John Milne, our great authority on seismology, has collected an extremely interesting series of data as to the curious changes that have taken place in the ocean bed since telegraphic cables have been laid down. The frequent breakages of cables have led to the examination of the suboceanic ground on which they have been laid, and it is found that slides and sinkings have occurred, in some cases amounting to hundreds of fathoms. These, it is important to note, are on the slopes of the continental margin, or, as it is called, the continental shelf, as, for example, off the coast of Chile. It is there, where the earth's crust is peculiarly in a state of unstable equilibrium, that we might expect to find such movements; and, therefore, soundings along the continental margins, at intervals of, say, five years, might furnish science with data that might be turned to good account. Another important problem to attack, and that in the near future, is that of oceanic islands. I say in the near future, because it is to be feared that very few islands now remain unmodified by contact with Europeans. Not only have the natives been affected, both in physique and in customs, but the introduction of European plants and animals has to a greater or less extent modified the native fauna and flora. Dr. John Murray, of the Challenger, has set a good example in this direction by sending a young official from the Natural History Museum to Christmas Island, in the Indian Ocean, one of the few untouched islands that remain, lying far away from any other land, to the southeast of the Keelings. What islands are to the ocean, lakes are to the land. It is only recently that these interesting geographical features have received the attention they deserve. Rivers are of not less geographical interest than lakes, and these have also recently been the subject of special investigation by physical geographers. But time does not admit of my going farther. I might have pointed out the wide and vastly interesting field presented by what the Germans call anthropogeography, dealing with the interrelations between humanity and its geographical environment. Geography, Mr. Mackinder has said, is the physical basis of history; it is, indeed, the physical basis of all human activity, and from that standpoint the field for geographical research is unbounded. But I can only hint at this. I have endeavored to indicate what are some of the leading geographical problems of the future, first in order to show at this somewhat critical epoch how very much yet remains to be done, how many important lines of inquiry are open to the geographical student.

[Continued from SUPPLEMENT, No. 1132, page 18092.]

ADDRESS BY SIR JOHN EVANS,

K.C.B., D.C.L., LL.D., Sc.D., Treas. R.S., V.P.S.A., For. Sec. G. S.; Correspondant de l'Institut de France, etc.; President of the British Association for the Advancement of Science.*

IT must, moreover, be remembered that in what are probably the earliest of the palæolithic deposits of the eastern counties, those at the highest level, near Brandon, in Norfolk, where the gravels contain the largest proportion of pebbles derived from glacial beds, some of the implements themselves have been manufactured from materials not native to the spot but brought from a distance, and derived in all probability either from the bowlder clay or from some of the beds associated with it.

We must, however, take a wider view of the whole question, for it must not for a moment be supposed that there are the slightest grounds for believing that the civilization, such as it was, of the palæolithic period originated in the British Isles. We find in other countries implements so identical in form and character with British specimens that they might have been manufactured by the same hands. These occur over large areas in France under similar conditions to those that prevail in England. The same forms have been discovered in the ancient river gravels of Italy, Spain, and Portugal. Some few have been recorded from the north of Africa, and analogous types occur in considerable numbers in the south of that continent. On the banks of the Nile, many hundreds of feet above its present level, implements of the European types have been discovered; while in Somaliland, in an ancient river valley at a great elevation above the sea, Mr. Seton-Karr has collected a large number of implements formed of flint and quartzite, which, judging from their form and character, might have been dug out of the drift deposits of the Somme or the Seine, the Thames or the ancient Solent.

In the valley of the Euphrates implements of the same kind have also been found, and again farther east in the lateritic deposits of southern India they have been obtained in considerable numbers. It is not a little remarkable, and is at the same time highly suggestive, that a form of implement almost peculiar to Madras reappears among implements from the very ancient gravels of the manzanares at Madrid. In the case of the African discoveries we have as yet no definite palæontological evidence by which to fix their antiquity, but in the Narbadá valley of western India palæolithic implements of quartzite seem to be associated with a local fauna of Pleistocene age, comprising, like that of Europe, the elephant, hippopotamus, ox, and other mammals of species now extinct. A correlation of the two faunas with a view of ascertaining their chronological relations is beset with many difficulties, but there seems reason for accepting this Indian Pleistocene fauna as in some degree more ancient than the European.

Is this not a case in which the imagination may be fairly invoked in aid of science? May we not from these data attempt in some degree to build up and reconstruct the early history of the human family? There, in eastern Asia, in a tropical climate, with the means of subsistence readily at hand, may we not picture to ourselves our earliest ancestors gradually developing from a lowly origin, acquiring a taste for hunting, if not indeed being driven to protect themselves from the beasts around them, and evolving the more complicated forms of tools or weapons from the simpler flakes which had previously served them as knives? May we not imagine that, when once the stage of civilization denoted by these palæolithic implements had been reached, the game for the hunter became scarcer, and that his life in consequence assumed a more nomad character? Then, and possibly not till then, may a series of migrations to "fresh woods and pastures new" not unnaturally have ensued, and these following the usual course of "westward toward the setting sun," might eventually lead to a palæolithic population finding its way to the extreme borders of western Europe, where we find such numerous traces of its presence.

How long a term of years may be involved in such a migration it is impossible to say, but that such a migration took place the phenomena seem to justify us in believing. It can hardly be supposed that the process that I have shadowed forth was reversed, and that man, having originated in northwestern Europe, in a cold climate where clothing was necessary and food scarce, subsequently migrated eastward to India and southward to the Cape of Good Hope! As yet, our records of discoveries in India and Eastern Asia are but scanty; but it is there that the traces of the cradle of the human race are, in my opinion, to be sought, and possibly future discoveries may place upon a more solid foundation the visionary structure that I have ventured to erect.

It may be thought that my hypothesis does not do justice to what Sir Thomas Browne has so happily termed "that great antiquity, America." I am, however, not here immediately concerned with the important neolithic remains of all kinds with which this great continent abounds. I am now confining myself to the question of palæolithic man and his origin, and in considering it I am not unmindful of the Trenton implements, though I must content myself by saying that the "turtleback" form is essentially different from the majority of those on the wide dissemination of which I have been speculating, and, moreover, as many here present are aware, the circumstances of the finding of these American implements are still under discussion.

Leaving them out of the question for the present, it may be thought worth while to carry our speculations rather further, and to consider the relations in time between the palæolithic and the neolithic periods. We have seen that the stage in human civilization denoted by the use of the ordinary forms of palæolithic implements must have extended over a vast period of time if we have to allow for the migration of the primeval hunters from their original home, wherever it may have been in Asia or Africa, to the west of Europe, including Britain. We have seen that, during this migration, the forms of the weapons and tools made from silicious stones had become, as it were, stereotyped, and further that, during the subsequent extended period implied by the erosion of the valleys, the modifications in the form of the implements and the changes in the fauna associated with the men who used them were but slight.

At the close of the period during which the valleys were being eroded comes that represented by the latest occupation of the caves by palæolithic man, when both in Britain and in the south of France the reindeer was abundant; but among the stone weapons and implements of that long troglodytic phase of man's history not a single example with the edge sharpened by grinding has as yet been found. All that can safely be said is that the larger implements as well as the larger mammals had become scarcer, that greater power in chipping flint had been attained, that the arts of the engraver and the sculptor had considerably developed, and that the use of the bow had probably been discovered.

Directly we encounter the relics of the neolithic period, often, in the case of the caves lately mentioned, separated from the earlier remains by a thick layer of underlying stalagmite, we find flint hatchets polished at the edge and on the surface, cutting at the broad and not at the narrow end, and other forms of implements associated with a fauna in all essential respects identical with that of the present day.

Were the makers of these polished weapons the direct descendants of palæolithic ancestors whose occupation of the country was continuous from the days of the old river gravels? or had these long since died out, so that after western Europe had for ages remained uninhabited, it was repeopled in neolithic times by the immigration of some new race of men? Was there in fact a "great gulf fixed" between the two occupations? or was there in Europe a gradual transition from the one stage of culture to the other?

It has been said that "what song the Sirens sang, or what name Achilles assumed when he hid himself among women, though puzzling questions, are not beyond all conjecture;" and though the questions now proposed may come under the same category, and must await the discovery of many more essential facts before they receive definite and satisfactory answers, we may, I think, throw some light upon them if we venture to take a few steps upon the seductive, if insecure, paths of conjecture. So far as I know, we have as yet no trustworthy evidence of any transition from the one age to the other, and the gulf between them remains practically unbridged. We can, indeed, hardly name the part of the world in which to seek for the cradle of neolithic civilization, though we know that traces of what appear to have been a stone-using people have been discovered in Egypt, and that what must be among the latest of the relics of their industry have been assigned to a date some 3,500 to 4,000 years before our era. The men of that time had attained to the highest degree of skill in working flint that has ever been reached. Their beautifully made knives and spearheads seem indicative of a culminating point reached after long ages of experience; but whence these artists in flint came or who they were is at present absolutely unknown, and their handiworks afford no clew to help us in tracing their origin.

Taking a wider survey, we may say that, generally speaking, not only the fauna but the surface configuration of the country were, in western Europe at all events, much the same at the commencement of the neolithic period as they are at the present day. We have, too, no geological indications to aid us in forming any chronological scale.

The occupation of some of the caves in the south of France seems to have been carried on after the erosion of the neighboring river valleys had ceased, and so far as our knowledge goes these caves offer evidence of being the latest in time of those occupied by man during the palæolithic period. It seems barely possible that though in the north of Europe there are no distinct signs of such late occupation, yet that, in the south.

* Delivered at Toronto, August 18, 1897.

man may have lived on, though in diminished numbers; and that in some of the caves, such, for instance, as those in the neighborhood of Mentone, there may be traces of his existence during the transitional period that connects the palæolithic and neolithic ages. If this were really the case, we might expect to find some traces of a dissemination of neolithic culture from a north Italian center, but I much doubt whether any such traces actually exist.

If it had been in that part of the world that the transition took place, how are we to account for the abundance of polished stone hatchets found in Central India? Did neolithic man return eastward by the same route as that by which in remote ages his palæolithic predecessor had migrated westward? Would it not be in defiance of all probability to answer such a question in the affirmative? We have, it must be confessed, nothing of a substantial character to guide us in these speculations; but, pending the advent of evidence to the contrary, we may, I think, provisionally adopt the view that, owing to failure of food, climatal changes, or other causes, the occupation of western Europe by palæolithic man absolutely ceased, and that it was not until after an interval of long duration that Europe was repeopled by a race of men immigrating from some other part of the globe where the human race had survived, and in course of ages had developed a higher stage of culture than that of palæolithic man.

I have been carried away by the liberty allowed for conjecture into the regions of pure imagination, and must now return to the realms of fact, and one fact on which I desire for a short time to insist is that of the existence at the present day, in close juxtaposition with our own civilization, of races of men who, at all events but a few generations ago, lived under much the same conditions as did our own neolithic predecessors in Europe.

The manners and customs of these primitive tribes and peoples are changing day by day, their languages are becoming obsolete, their myths and traditions are dying out, their ancient processes of manufacture are falling into oblivion, and their numbers are rapidly diminishing, so that it seems inevitable that ere long many of these interesting populations will become absolutely extinct. The admirable Bureau of Ethnology instituted by our neighbors in the United States of America has done much toward preserving a knowledge of the various native races in this vast continent; and here in Canada the annual Archæological Reports presented to the minister of education are rendering good service in the same cause.

Moreover, the committee of this association appointed to investigate the physical characters, languages, and industrial and social conditions of the northwestern tribes of the Dominion of Canada is about to present its twelfth and final report, which, in conjunction with those already presented, will do much toward preserving a knowledge of the habits and languages of those tribes. It is sad to think that Mr. Horatio Hale, whose comprehensive grasp of the bearings of ethnological questions, and whose unremitting labors have so materially conduced to the success of the committee, should be no longer among us. Although this report is said to be final, it is to be hoped that the committee may be able to indicate lines upon which future work in the direction of ethnological and archæological research may be profitably carried on in this part of Her Majesty's dominions.

It is, however, lamentable to notice how little is being or has been officially done toward preserving a full record of the habits, beliefs, arts, myths, languages and physical characteristics of the countless other tribes and nations more or less uncivilized which are comprised within the limits of the British Empire. At the meeting of this association held last year at Liverpool it was resolved by the general committee "that it is of urgent importance to press upon the government the necessity of establishing a bureau of ethnology for Greater Britain, which, by collecting information with regard to the native races within and on the borders of the empire, will prove of immense value to science and to the government itself." It has been suggested that such a bureau might, with the greatest advantage and with the least outlay and permanent expense, be connected either with the British Museum or with the Imperial Institute, and the project has already been submitted for the consideration of the trustees of the former establishment.

The existence of an almost unrivaled ethnological collection in the museum, and the presence there of officers already well versed in ethnological research, seem to afford an argument in favor of the proposed bureau being connected with it. On the other hand, the Imperial Institute was founded with an especial view to its being a center around which every interest connected with the dependencies of the empire might gather for information and support. The establishment within the last twelve months of a scientific department within the institute, with well appointed laboratories and a highly trained staff, shows how ready are those concerned in its management to undertake any duties that may conduce to the welfare of the outlying parts of the British Empire; a fact of which I believe that Canada is fully aware. The institute is therefore likely to develop, so far as its scientific department is concerned, into a bureau of advice in all matters scientific and technical, and certainly a bureau of ethnology such as that suggested would not be out of place within its walls.

Wherever such an institution is to be established, the question of its existence must of necessity rest with Her Majesty's government and treasury, inasmuch as without funds, however moderate, the undertaking cannot be carried on. I trust that in considering the question it will always be borne in mind that in the relations between civilized and uncivilized nations and races it is of the first importance that the prejudices and especially the religious or semireligious and caste prejudices of the latter should be thoroughly well known to the former. If but a single "little war" could be avoided in consequence of the knowledge acquired and stored up by the Bureau of Ethnology preventing such a misunderstanding as might culminate in warfare, the cost of such an institution would quickly be saved.

I fear that it will be thought that I have dwelt too long on primeval man and his modern representatives, and that I should have taken this opportunity to discuss some more general subject, such as the advances made in the various departments of science since last this association met in Canada. Such a subject would no doubt have afforded an infinity of interesting topics on which to dilate. Spectrum analysis, the origin and nature of celestial bodies, photography, the connection between heat, light, and electricity, the practical applications of the latter, terrestrial magnetism, the liquefaction and solidification of gases, the behavior of elements and compounds under the influence of extreme cold, the nature and uses of the Roentgen rays, the advances in bacteriology and in prophylactic medicine, might all have been passed under review, and to many of my audience would have seemed to possess greater claims to attention than the subject that I have chosen.

It must, however, be borne in mind that most, if not indeed all, of these topics will be discussed by more competent authorities in the various sections of the association by means of the presidential addresses or otherwise. Nor must it be forgotten that I occupy this position as a representative of archæology, and am therefore justified in bringing before you a subject in which every member of every race of mankind ought to be interested—the antiquity of the human family and the scenes of its infancy.

Others will direct our thoughts in other directions, but the farther we proceed the more clearly shall we realize the connection and interdependence of all departments of science. Year after year, as meetings of this association take place, we may also foresee that "many shall run to and fro and knowledge shall be increased." Year after year advances will be made in science, and in reading that book of nature that lies ever open before our eyes, successive stones will be brought for building up that temple of knowledge of which our fathers and we have labored to lay the foundations. May we not well exclaim with old Robert Recorde?

"Oh woorthy temple of Goddes magnificence: Oh throne of glorye and seate of the lorde: thy substance most pure what tonge can describe? thy signes are so wonderous, surmountinge mannes witte, the effects of thy motions so diuers in kinde: so harde for to searche, and worse for to fynde—Thy woorkes are all wonderous, thy cunning unknowen: yet seedes of all knowledge in that booke are sowen—And yet in that boke who rightly can reade, to all secrete knowledge it will him straighte leade."*

PROF. MAYER.

ALFRED MARSHALL MAYER.†

A MAN of science, whose work was unique in the domain which he had selected, and who will long be held in warm remembrance by a large circle of friends, has lately passed away.

In 1784 there emigrated to America a young German, Christian Mayer, a member of an ancient family in the city of Ulm, in Würtemberg. He made his home in Baltimore, where, by strong intelligence and well directed industry, he amassed a fortune. To his two sons, Charles F. and Brantz, he gave the best educational advantages of the day. The former became a prominent lawyer, well known in the best social circles of Baltimore on account of his refinement and broad literary culture, while the latter traveled and wrote extensively, his historical work, especially in connection with Mexico, being of high authority and acknowledged value.

On the 13th day of November, 1836, a son was born to Charles F. Mayer. At an early age the boy exhibited great mechanical ingenuity and a lively interest in the external world of nature. At St. Mary's College, in Baltimore, he was afforded all the usual facilities for an elementary liberal education, and especially for classical training; but this did not suit his native bent. At the age of sixteen years he gave up the school room, and the following two years were spent chiefly in the workshop and the draughting room of a mechanical engineer. Here was abundant opportunity for acquiring familiarity with the use of tools and developing manipulative skill. At the same time there was a continual stimulus to private study in connection with the daily application of the laws of physics and mechanics. This course of study in applied science was a natural precursor to the resumption of more systematic work, not in the class room, but in the laboratory. A course of chemistry was undertaken, and two years were spent largely in mastering the principles and processes of quantitative analysis. It was during these years of private study and practical work that young Mayer attracted the attention of a man whose personal influence was chiefly instrumental in determining the future direction of the student's energies. Joseph Henry was at this time secretary of the Smithsonian Institution, and for thirty years he had been identified with the advancement of pure science in America. Industrial science needs no advocates. Its importance is recognized by all. Its immediate connection with material progress and its quick response to commercial demands are sufficient to bring within the ranks of its devotees the great majority of those who undertake laboratory work with a definite purpose. Henry had never underrated the value or the need of industrial science, but he had emphasized the importance of investigation from the more unselfish standpoint of one who regarded intellectual acquisition as a priceless good in itself apart from all commercial recompense. He apprehended the brightness, the alertness, the originality of the Baltimore student, and accorded him that sympathetic recognition which constitutes the greatest stimulus that a young man can receive. The friendship of an acknowledged master makes a willing and easily directed pupil. Ideals of excellence are thus formed for life. Subsequent experience may sometimes modify these, but they are rarely ever discarded.

At the early age of twenty years Mayer was appointed to the chair of physics and chemistry in the University of Maryland. He had already, during the previous year, published his first contribution to science, the description of a "new apparatus for the determination of carbonic acid." This was soon republished in Germany.

His new duties absorbed now most of his time, but a second paper appeared in the American Journal of Science, in 1857, on the estimation of the weights of very small portions of matter. In this he showed that by the deflection of a fine glass fiber it is possible to estimate a variation in weight so small as the thousandth

* Preface to Robert Recorde's Castle of Knowledge, 1556.

† By Prof. W. Le Conte Stevens, in Science. Prof. Stevens is particularly well adapted to write of his friend, owing to their mutual love for acoustics, in which branch of physics they have both done notable work. Prof. Mayer will be specially remembered by readers of the SCIENTIFIC AMERICAN SUPPLEMENT, by reason of his articles in 1877–1879, on "The Minute Measurements of Modern Science." The following is a synopsis of these articles, with the numbers of the papers: I, Size of the magnitudes to be measured, 56; II, Micrometer screw, 58; III, Measuring by means of micrometer screw with contact level, 60; IV, Spherometer, 62; V, Micrometer microscope, 64; VI, Compound microscope applied to minute measurements, 67; VII, Vernier and vernier microscope, 72; VIII, Cathetometer, 77; IX, Dividing engine, 80; X, Construction of a perfect screw, 92; XI, Rotating mirrors applied to the measurement of minute lengths, Saxton's comparator, 96; XII, XIII, XIV, Saxton's comparator, 100, 103, 107; XV, Horizontal pendulum, 112; XVI, Use of tuning fork, 160; XVII, Wheatstone's experiments to measure velocity of electricity, 163; XVIII, XIX, On nature and duration of electric discharge; Feddersen, Henry, Rood and Mayer's experiments, 168, 175; XX, Measurement of light waves, 177.

part of a milligramme. In 1859 he accepted a chair in Westminster College, Missouri, where two years were spent; but the equipment of this institution was insignificant and no original work was accomplished. The breaking out of the civil war determined his return to Baltimore, and in 1863 he went to Paris, where two years were occupied in special study, chiefly under the direction of Regnault. The influence of the great French physicist, and the general atmosphere of the University of Paris, strengthened the bias in favor of pure science which had been received in youth from Henry.

Soon after his return to America, in 1865, Prof. Mayer was called to the chair of physics and chemistry at Pennsylvania College, in Gettysburg, which he gave up in 1867 to accept that of physics and astronomy in Lehigh University. This in turn was renounced in 1871 for the purpose of joining in the upbuilding of the new Stevens Institute of Technology, at Hoboken, with which his connection continued up to the time of his death, July 13, 1897. It is with this institution, therefore, that his name will always be chiefly identified, though his researches were for the most part in channels somewhat removed from those that are usually characteristic of an engineering school. Its instrumental equipment was unusually good, and proximity to a great metropolis afforded the intellectual stimulus and the prompt recognition of merit which are wanting in isolated institutions of learning.

While connected with Lehigh University Prof. Mayer designed an astronomical observatory and superintended its construction. He erected the instruments and, without assistance, finished the tedious work of adjusting them. A series of observations on Jupiter followed, and its publication was reproduced in England. During the summer vacation of 1869 he was deputed by the United States government to take charge of a party of astronomers at Burlington, Iowa, where the solar eclipse of August 7 was observed. During the eclipse more than forty successful photographs were taken, each exposure lasting 0·002 second. Four of these were during the eighty-three seconds of totality. This was in the early days of instantaneous photography and was accounted an unusual feat. An abstract of the results of measurements on these photographs was published in the Journal of the Franklin Institute. In the same journal, about this time, he published a number of articles on physical and astrophysical subjects. At the Salem meeting of the Scientific Association, 1869, a paper was read "On the Thermodynamics of Waterfalls." At Trenton Falls and at Niagara Falls careful observations had been made on the temperature of the water at the top of the cataract and just beyond the point of impact at the bottom. The arrest of motion develops heat, and this was found to be manifested in a measurable rise of temperature, when the air was charged with moisture and not much warmer or colder than the water, the change being in accordance with calculation based on Joule's equivalent. But under other conditions this effect was masked to such an extent by the cooling effect of evaporation and conduction that there was sometimes a lower temperature at the bottom than at the top.

Soon after entering upon his duties at Hoboken, Prof. Mayer began the series of investigations in acoustics for which he is, perhaps, best known, and which made him decidedly the leading authority on this subject in America. In the first of his papers he showed how the co-vibration of two nearly unisonant tuning forks may be utilized to demonstrate Doppler's well known principle that wave length may be modified by translation of the vibrating body. This was soon followed by another paper in which he gave a method of detecting the phases of vibration in the air surrounding a sounding body. Two resonators responding to the pitch of the source were employed, each connected with a manometric capsule. One of these resonators being fixed and the other movable, the recurring changes in the compound flame image gave the means of measuring wave length directly in the vibrating air and exploring the form of the wave surface. A simple and precise method was developed from this for measuring wave lengths and velocities of sound in gases at various temperatures; and an acoustic pyrometer was devised by which furnace temperatures were capable of measurement with a degree of accuracy approaching that of the air thermometer. The same optical method of interference was then further applied to the determination of the relative intensities of sounds. The range of application of this method is somewhat limited, but within this range it is more precise than any other method devised for the same purpose. One application was to the measurement of the powers of various substances to transmit and to reflect sonorous vibrations. An investigation of the relative absorbing powers of different media for sound led to an approximate determination of the mechanical equivalent of an aërial sonorous vibration. The energy per second given forth in aërial vibrations by an Ut_3 fork (256 vd.), set in motion by intermittent electro-magnetic action and placed before an appropriate resonator, was found to be about one millionth of Joule's unit, or enough to raise one gramme through a height of ten centimeters. This result was accomplished by measuring the relative intensities of the sound given forth by the same fork, first when vibrating freely, then when the motion of its prongs was damped by the expenditure of part of its energy on India rubber. The rise of temperature of the rubber was measured by use of thermopile and galvanometer, and its specific heat determined by ordinary methods. The difficulties attendant upon such an experiment are very great, and no one but an experimentalist of exceptional skill and patience would be apt to undertake it.

These strictly physical investigations led Prof. Mayer into the domain of physiology in its bearing upon the phenomena of audition. The most important principle in acoustics is that of harmonic motion, simple and compound, as embodied in Fourier's theorem. Helmholtz was the first to apply this to the analysis of musical quality, and in doing so the subjective method of resonators was utilized with great skill. Prof. Mayer sought objective methods and devised several of these, the most striking of which was that of employing tense threads as media for the conveyance of energy from a vibrating membrane to mounted tuning forks adjusted in pitch to respond to the components of the compound sound under examination. Recognizing the capacity of the ear, when sufficiently trained, to accomplish this analysis to a considerable extent without instrumental aid, he sought to learn the mechanism of the auditory apparatus of some of the lower types of animal life. Some new and interesting facts were thus discovered in relation to the function of the antennæ of the mosquito in audition, and he showed how an insect may determine the direction of sounds by means of its antennæ. In this connection good reason was found for the belief that the terminal auditory nerve fibrils in the human ear vibrate just half as often in a given time as the membrane of the tympanum and the ossicles. This hypothesis partially accounts for the marked difference in quality when the same sound is successively heard, first directly through the open ear and then through the medium of the bony portions of the head.

Prof. Mayer's most important acoustic research was his determination of the law connecting the pitch of a sound with the duration of the residual sensation in the ear. An explanation of the method adopted cannot be here given without entering unduly into details. This law gave a quantitative character to results which Helmholtz had attained only qualitatively. It is of fundamental importance in its application to musical harmony. It explains why certain combinations of tones which are harmonious in the upper portions of the musical scale become rough and discordant in the lower portions. This mere fact the musical composer was long compelled to recognize, though hitherto it had been inexplicable. The labor involved in this work was great, and before its completion the investigator's power of audition in one ear was thereby permanently impaired. The first experiments were published in 1874; a redetermination was made in 1875, and again with improved apparatus in 1893. He received the assistance of the most accomplished musical experts, including Madame Seiler, who had been associated with Helmholtz for a somewhat similar purpose, and Dr. Rudolph Koenig, of Paris, whose training in the detection of musical beats is unrivaled. Dr. Koenig, in 1893, rendered important service in ascertaining the limitations of what may now be properly called "Mayer's Law." This law is expressed by an equation in which the duration of the residual sensation is given as a function of vibration frequency, and this equation is readily translated into a curve. Between the limits of 100 and 4,000 vibrations per second there is closer accordance between the results of calculation and observation than in the case of Fechner's law, or indeed any other physiological law for which the attempt has been made to express sensation mathematically. Between 200 and 2,000 vibrations, including the range most constantly resorted to in music, the accordance is satisfactory, even when measured by physical rather than physiological standards. Due recognition of these important contributions to acoustic theory have been made by Mr. Ellis in his translation of Helmholtz's "Tonempfindungen" and by Prof. Zahm in his recent book (1892) on "Sound and Music." Mr. Ellis gave a special lecture in London for the purpose of explaining these discoveries and their application to the principles of musical harmony.

It was natural for Prof. Mayer to apply acoustic methods in work primarily undertaken for other purposes. In 1876 he devised improvements in what is now generally known as the electrographic method for the measurement of the velocity of projectiles and the determination of pitch. He utilized the spark from an induction coil for the purpose of marking seconds upon the sinuous trace of a tuning fork on smoked paper, and attained results of great accuracy. He studied with care the laws of vibration of tuning forks, and was the first to give accurately the correction to be applied in all such determinations on account of variation in temperature of the fork. Between 1889 and 1894 he conducted an elaborate research on the variation of the modulus of elasticity of various materials with change of temperature, as indicated by the transverse vibration of bars. From the observed pitch the velocity of propagation of sound in the bar is found, and this gives the modulus of elasticity. For the accurate determination of pitch it was necessary to visit Paris, where access was had to Dr. Koenig's grand tonometer, and where this accomplished acoustician freely gave his time and skill in furtherance of the work. The remarkable regularity in the results shows that this acoustic method, as conducted, is worthy of the greatest reliance. Among the materials thus studied was aluminum. Its modulus was found to be subject to large variation, and in every respect it is far inferior to steel for acoustic purposes.

(To be continued.)

ROSA WICHURAIANA.

THERE are very few of the wild types of Rosa whose flowering time comes so late in the year as the end of July and the beginning of August, but of those few R. Wichuraiana is one. It is of very recent introduction, but the distinct character of its growth and the late date at which it blossoms have already obtained for it considerable notice in this country, although not so much as in the United States, where it is already a popular shrub. It is a native of Japan, and reached this country by the way of the United States about five or six years ago. The two characters which more than any others distinguish this rose are its procumbent habit and the very lustrous dark green color of its leaves, these being, indeed, so bright on both sides as to suggest their being coated with varnish. Each one consists of five, seven or nine leaflets, which are oblong or elliptical, serrated, and from ½ to 1 inch long. The petiole bears a few short spines and bristles, and the stipules have their margins set with glandular teeth. On the strong, succulent, non-flowering shoots of the current year the wood is armed with stout curved spines, but on the thinner flowering shoots of the following year they are mostly arranged in pairs just beneath each node. The flowers are of the purest white, and the clusters appear just above the dense carpet of glossy leaves, which completely covers the soil. Each flower is upward of two inches in diameter, the petals (normally five) often numbering six or seven under cultivation. This species should be given a rich soil, and, what is of equal or greater importance, the sunniest possible position. It is, no doubt, the intense and prolonged sunshine it receives in North America that causes it to flower so abundantly there. It is a plant of vigorous and luxuriant growth, and can be increased with the greatest ease by means of cuttings put in during the next two or three weeks.—The Gardeners' Chronicle.

ROSA WICHURAIANA, HARDY ROSE—FLOWERS WHITE.

A kerosene incandescent burner is made which will fit on an ordinary kerosene lamp. The kerosene is drawn up into a small chamber by a number of wicks, and is there vaporized by a small external flame. After two and one-half minutes the heat in this little chamber is sufficient to supply the vapor for a flame which raises the mantle to white heat. The mantle is similar to that used with a coal gas flame. A great drawback about this burner is that two and one-half minutes must elapse after the first application of light till the lamp is ready for use. A similar burner is made to use with a methylated spirits flame.—Uhland's Wochenschrift.

ENGINEERING NOTES.

Paris (France) is to be supplied with well water from the departments of the Eure and Loire, some 480 ft. above the level of Paris and over 100 miles away.—Zeitschrift für Architectur.

Cork paving has been tested in England, and is found to be very noiseless, elastic and waterproof. It gives a good hold to the feet, is never slippery, and withstands the action of the weather very well. The wear due to friction is also very small.—Monatschrift für den Oeffentlichen Baudienst.

A plan for connecting South and West Australia by railroad is under consideration. The distance between the ends of their railroad systems is only 553 miles, but the country to be traversed is an arid desert, and reservoirs must be built at twenty-five mile intervals along the whole line. The cost will be about $10,000,000.

The strongest steel ropes ever made are probably the two recently finished, says Uhland's Wochenschrift, by Messrs. Felten and Guilleaume, Mülheim, Germany, for a bridge over the Argen River, near the Boden Lake. These ropes are made of 259 wires, each about a quarter of an inch thick. They weigh some 135 lb. per yard, and their strength is such that it would require a force of 1,800,000 lb. weight to tear them. The bridge for which they are made will be 162 ft. long.

The Theatre Francais, at Paris, has a peculiar device to insure the greatest possible safety for the audience. Not only can the scene be separated from the audience by a hermetically closing steel curtain, but the roof of the scene can be uncovered at a moment's notice, so that a draught of air is produced which carries away the smoke and noxious gases produced in the fire. These, it is said, constitute the greatest danger to the audience, often rendering escape quite impossible. It is on the scene that the fire usually breaks out.—Monatschrift für den Oeffentlichen Baudienst.

Very few know it, but it is a fact, says the Washington Star, that the Pension Office Building is the largest brick building in the world. It has been subjected to much criticism, but it can stand it, for as time passes along there are many things seen about it that escaped notice when it was newer. In all there are over 10,000,000 bricks in the building. General Meigs took liberties with bricks that no other architect had ever attempted. He not only used bricks exclusively for the building, but he used them in constructing the stairs throughout the building. In the matter of stair building bricks have often been used for the riser, but the step has always been of iron, wood, slate or stone. In the Pension Office both riser and step are of brick. As a brick building, therefore, pure and simple, it is unique in construction, outside of the fact that it is the largest exclusively brick building in the world.

Some curious effects of the tests of the new magazine rifles in actual service are noted in Engineering. Cordite was accused of causing rapid wear of the rifling, and this charge must have had some foundation, as the Metford rifling has been abandoned in the weapons now issued, and has been replaced by the system devised by Rigby, which is said to wear well and give more accurate shooting than the Mannlicher, Mauser or Lebel systems. Certainly the wear cannot now be a very serious matter, if the reports can be relied on that accurate shooting has been made even after firing some thousands of rounds and the weapon is still serviceable after 8,000 or 9,000 rounds have been fired. In the Tochе punitive expedition the new Dumbum bullet will be employed, that originally used having proved deficient in stopping power. In the Chitral campaign one man was six times shot, and nevertheless he recovered. The private soldiers are, accordingly, losing confidence in the weapon.

The Railroad Gazette says: "The people of George Stephenson's race have not kept railroads to themselves, but so far they have a long lead of the rest of the world in constructing them. There is not much room in Great Britain for a great mileage, and in Europe, of the total 155,284 miles, only 20,977 miles are on British territory. But of the 26,890 miles in Asia, 19,700 miles are on such territory; in Africa, 2,845 miles out of 8,169; in America, of the 48,005 miles outside of the United States, 16,719 miles are British, and of course, all the 13,888 miles in Australia. Altogether, there are 74,129 miles of railroad in the British possessions, which added to the 181,717 miles in the United States (all the figures are for 1895), makes the considerable figure of 255,846 miles, which is nearly three-fifths of the railroads of the world. And this takes no account of 7,127 miles of Mexican railroad, all built with American and English capital and skill, and nearly all with their materials, nor of the countless lines built elsewhere in the four quarters of the globe with English money and skill, and mostly with English iron and machinery. We seem to be pre-eminently the railroad race."

The successful beginning of the work at the new basic open-hearth steel plant in Birmingham, Ala., calls attention to the possible entrance of the South into the steel market, says the Engineering and Mining Journal. The output of that section in the past has been so closely limited to pig iron that it has not been considered at all as a competitor in steel or any finished products of steel. Of course the production is for the present so limited that it will hardly supply the needs of the Birmingham rolling mill; but there is little doubt that it can and will be increased considerably in the future. There does not seem to be any probability of the establishment of a new rail mill in the South; but a considerable trade in beams, girders and structural iron for Southern cities could be built up, and a mill at Birmingham could readily compete with the Pennsylvania works at all the cities along the Ohio, and would have a considerable advantage over them in any town on or west of the Mississippi below Cairo. It is, moreover, a question still, whether with the present low costs, both of material and labor, it would not be possible for Southern steel works to furnish billets at a price which would enable them to take at least part of the trade of those Eastern mills which work on purchased billets. It is quite possible, also, that a trade in billets and tin plate bars for export might be built up, while there are possibilities in wire rods also. As long as costs are kept down to the present limit, there will be no trouble in finding a market for Southern steel.

ELECTRICAL NOTES.

In London, England, electric propulsion is shortly to be substituted for horse traction. The lines are owned by the town, but are to be let out to companies as soon as the alterations are complete.—Uhland's Wochenschrift.

The number of persons carried by the electric cars at the Berlin Industrial Exhibition (Germany) reached its maximum on August 29, when 35,800 persons traveled on the lines, and was smallest on the 19th of May, when only 4,700 fares were taken.—Zeitschrift für Architectur.

The number of lamps supplied with the electric current in Paris (France) at the end of October, 1896, was 545,914, in London (England) 1,178,000. The current used in Paris amounted to 8,107,253 kilowatt hours, in London about 19,000,000 kilowatt hours. In Paris the price of 1 kilowatt hour is 25 cents, in London about half as much.—Zeitschrift für Architectur.

The electric lighting of railway cars is constantly coming more in use in Switzerland. The number of cars lit by electricity at the end of the year 1896 was 525. On the Jura-Simplon line electric lighting will be introduced throughout by the end of the current year. The Swiss Central Railroad has furnished all its new wagons with electric lighting appliances for the last two years. The Northeast Railroad has ordered 65 wagons, which are to be lighted by electricity. Many smaller lines, too, have followed the general motion.—Monatschrift für den Oeffentlichen Baudienst.

The municipal council of Berlin, Germany, has decided, by 58 votes against 24, that the horse cars in the German capital shall be replaced by a tramway propelled by electricity. Among the resolutions passed are the following: The right of other companies to use the tracks was restricted to a certain three sections, and 410 yards. The company shall not keep a man at work more than ten hours in succession, except in special, rare cases. Season tickets are to be issued for any line, not as heretofore for any two lines. The cars are expected to make their first trip in October.—Uhland's Wochenschrift.

A practical electrical plowing installation has been put down in France by M. Felix Prat, in the department of Tarn, says The Engineer. The power is derived from a turbine working a dynamo, the current from which is distributed to different points on the estate by four overhead lines, with copper conductors, in the form of a cable. Two of these lines are 1800 and the remaining two 1600 meters in length. These lines, wherever possible, are supported on trees—strong poplars—in order to economize posts, while securing rigid supports. The plow is drawn by a simple windlass worked by the dynamo, and can be worked to a distance of 450 meters on each side of the cable line.

A number of electrical cabs, belonging to the London Electrical Cab Company, have commenced to ply for hire in the streets of London at the same fares as are charged for the horse vehicles they are designed to supplant. In shape these cabs, which carry two persons, resemble coupes; they run on four rubber tired wheels, are comfortably upholstered in leather, and possess the luxuries of spring cushions and electric light. The driver, who sits in front, has at his right hand a small steering wheel which acts on the front pair of wheels, and at his left a single lever which regulates the speed. By means of a foot lever the driver can apply the brake and at the same time cut off the current from the motor.

The transmission of power by electricity is, in some cases, retarded in coal pits because of their fiery nature, which renders it imperative that no sparking shall ever take place where it could ignite a fiery mixture of air and gas. With direct current motors it has therefore been necessary to completely box in the commutator and brushes, which renders them rather inaccessible. The great advantages of a three-phase or a two-phase alternate current system for such work cannot be too largely brought to the notice of the public, says the Electrical Engineer. When motors of the above type and of reasonable output are used, a simple throw-on switch is all that is required in the way of regulating gear, and the contacts of this switch are the only points at which sparking can occur. It is a comparatively easy task to box in this switch gear. The motors being without commutators or collecting rings, are absolutely free from sparking. The cables leading to the motors only need protection, and there is no lack on the market of well protected concentrics which will give safety in this direction. The motors have a good starting torque, and can be relied on to drive coal cutting machinery and hauling ropes. We must admit, however, that up to the present we have not seen a satisfactory arrangement for an electric locomotive to be worked in fiery pits.

Anybody who has had much to do with books knows that it is no easy task to keep them dusted, and extremists, in view of the difficulty, have gone so far as to assert that you should never dust books, says the Electrical Engineer. They should be left undisturbed till needed, and then the rust and dust of ages can be taken off with a napkin. This, however, is regarded as the heresy of sheer laziness, and the practical suggestion is now made that the fan motor is the thing wherewith to banish grime and dust from a well kept library. All that is necessary is to turn the breeze loose over the shelves, with the windows open, and in a few minutes the tops and covers will show up in all their pristine freshness. Obviously the fans can be portable, and either carried around in the hand by a long flexible cord or hitched up at suitable plugs and left spinning. Thus dust will not be able to settle for long and will rarely have a chance to accumulate even for a single day. Electricity has, therefore, another claim to use in libraries. Gas is well known to have a deleterious effect on books, and Mr. Blades, the well known bibliographer, once said there was nothing to equal it for rotting covers, even those of leather. With electricity, a public or private library will be better lighted and better kept, while it will also be safely available more hours of each day.

MISCELLANEOUS NOTES.

Vegetable ivory may be distinguished from real, animal ivory by applying a little sulphuric acid (concentrated) to the surface of the doubtful material. After some ten to fifteen minutes the vegetable product shows a pink coloration, which may be washed off with water, while true ivory remains unchanged.—La Science en Famille.

An improved composing box for type, with a wire net bottom, has recently been patented. The wire netting is made fine or coarse, according to the type it is intended for. Under the netting a wooden bottom can be slid in like a lid. The object of the invention is to facilitate the cleaning of the box, in which dust from wearing types collects.—Uhland's Wochenschrift.

The use of gas for heating purposes, particularly for large buildings and schools, is recommended on several grounds. The easy and quick regulation of the heat given results in considerable saving, and since radiating heat is employed, a quick rise of temperature is produced. The cost of installation and keeping in repair is small. Ample ventilation is afforded through the fireplaces, the air is not deteriorated by the fire and there is no danger of explosion.—Zeitschrift für Architectur.

A process by which not only the iron but also the phosphorus may be saved from iron ores containing phosphorus was recently patented. The ores are mixed with coal, the mixture is raised to a dull red heat, and steam is led over it. Water gas is formed, which acts as a reducing agent on the iron at a temperature when the phosphorus is left unaffected. The phosphorus then remains for later treatment.—Wiener Gewerbe Zeitung.

Spices are often adulterated with the residues of similar spices, from which, however, the essence has been extracted. Thus pepper has been found to contain some forty percent. of ginger residues. Ginger itself is often only one-half aromatic, the remainder being tasteless residue. Pepper is often adulterated with ground up pepper stems. Even unground pepper is forged, ordinary white grains being colored black and sold as Singapore pepper.—Uhland's Wochenschrift.

A new device for closing tins of preserves, etc., which was recently patented in Germany, has many advantages. The process of preparing the tinned products is carried on in vacuo, much time and heat being thereby saved, since many of the preserves have to be boiled. At the same time the vacuum is taken advantage of for closing the tins. The lid is applied, after a washer has been interposed, and then the tin is taken out into the air under atmospheric pressure. To open the tin, all that is required is to bore a hole in the lid.—Wiener Gewerbe Zeitung.

Roof tiles are made in Warsowi, Russia, of thin wood sheets, which are glued on one another so that the grain of the wood is crossed. A thin, elastic plate of wood is thus obtained, which cannot by any accident be twisted out of shape. These tiles resist the action of the weather very well, after they have received an application of pitch; they will even stand boiling in water for several hours. The weight of a roofing of these tiles is 12 pounds per square yard. They can be rendered fireproof by saturation with potassium silicate (soluble glass).—Monatschrift für den Oeffentlichen Baudienst.

The ambitious scheme of the Nippon Yusen Kaisha—the Japan Steamship Company—to compete with existing lines to Europe, America and Australia has been the reverse of successful, so far as the experience of six months' working is concerned, says The Engineer. The expenditure during that period was 4,968,365 yen, inclusive of 683,145 yen for depreciation and insurance and repair reserves, while the receipts totaled 4,805,048 yen, inclusive of 440,000 yen as government subsidy and 217,993 yen in respect of navigation bounties. This shows a loss on the half year of 163,326 yen, despite which the directors declared a dividend of 10 per cent., absorbing 605,000 yen, a feat accomplished by utilizing the whole of the "dividends equalization fund," amounting to 427,561 yen, and the balance of 190,538 yen brought forward from the previous account. This reduces the available funds to 2,561 yen, which sum is to be carried forward. The Syren observes from the report that the directors look for better things in the immediate future, but the opinion of those most competent to judge is that they will look in vain, unless the directors revert to the old state of things and discontinue these long distance voyages.

The Washington Star says: "Over 20,000,000 packages of vegetable, flower and field seed have been distributed by the Department of Agriculture during the past spring. This distribution has given to each member of Congress 40,000 packages of seed, at a total cost of $130,000. Over 1,000,000 of these packages were flower seed, and nearly 300,000 field seed, the balance being a great variety of vegetables. In the entire distribution nearly every variety of vegetable known to the agriculturists was distributed. There were 32 varieties of beans, 10 varieties of beets, 23 varieties of cabbage, 11 varieties of carrots, 19 varieties of sweet corn, 18 kinds of cucumbers, 30 kinds of lettuce, 19 varieties of muskmelons, 17 kinds of watermelons and 15 varieties of onions. The entire amount of seeds distributed was sufficient to plant an area of 355 square miles, or about six times the size of the District of Columbia. This is the largest distribution of seed ever attempted by the Department of Agriculture, and it is said that seedsmen all over the country are complaining that they do not make sales to farmers and others because they are getting all the seed they want free from the Department of Agriculture. The distribution of seed in 1893 amounted to 8,800 packages for each member of Congress, at a total cost of $66,548; in 1894 each Congressman got 16,000 packages, the entire cost to the government being $57,000; in 1895 the number of packages of seeds distributed was the same as in the previous year, but the total cost was reduced to $47,000. In 1896 Congressmen got 15,000 packages each, and the government paid $80,500 for the whole lot. During the past spring each member of Congress has received 40,000 packages of seeds, for which the government has paid $130,000."

[Continued from SUPPLEMENT, No. 1132, page 18101.]

DR. MOUNT BLEYER'S TREATMENT FOR CONSUMPTION BY ELECTRICITY.

On the application of the principles underlying these experiments in the sterilization of lung tissue in tuberculosis.

The primary action of the galvanic current—It increases the amount of ozone in the blood, as shown by chemical test of the blood in the arteries—With my theory of animal electricity.*

By J. MOUNT BLEYER, M.D., F.R.A.M.S., LL.D., New York City.

PRELIMINARY TESTS.

FOR a period of seventy-two hours before entering upon the examinations, we hung in various portions of my laboratory slips of specially prepared paper saturated with a solution of iodide of starch and others moistened with tincture of guaiac. These, we all know, are acknowledged tests upon ozone. We kept the papers under careful observation, examining in strong light at intervals of an hour, and as there was no evidence of a reaction at the end of the allotted time we were justified in concluding that the atmosphere of the laboratory was free from ozone and the other gases which act upon starch and guaiac. Next we directed our attention to nitrous compounds in the air, for the reason that they, if they exist in the slightest appreciable quantity, give us a reaction very much like that of ozone, and their presence must be excluded in order to give any sensitive test for ozone practical chemical value.

The test we applied for nitrous compounds is an extremely useful one, unusually sensitive, and we give its chemistry for the benefit of those who may desire to repeat our experiments. It is named Gries' test after its discoverer. He observed that in sulphanilic acid and naphthylamine we have a reagent which acts on nitrous acid, but not on H_2O_2 or O_3. This discovery Gries made while engaged in studying the action of diazo-benzene sulphonic acid on naphthylamine.

He obtained his diazo-benzene sulphonic acid by heating sulphanilic acid with nitrous acid and calls attention to the extreme delicacy of the reaction, minute traces of nitrous acid sufficing to produce a dark red color in the presence of dilute sulphuric acid. The colored substance formed is an amido-azo derivative of the formula

$$C_6H_4(SO_3H)N = NC_{10}H_6NH_2\dagger$$

called azo-amido-naphthalene-benzene-sulphonic acid. Prof. Slosvay‡ of the Polytechnic school at Buda-Pesth increases the sensitiveness of the reaction by substituting acetic for sulphuric acid, and he can detect with it nitrous acid in aqueous solution in a dilution of one part nitrous acid to one thousand million parts of water.

The formula of the test is :

$$\underset{\text{Sulphanilic acid}}{C_6H_4NH_2(SO_3H)} + \underset{\text{Naphthylamine}}{C_{10}H_7NH_2} + HNO_2 =$$

$$C_6H_4(SO_3H)N = HNC_{10}H_6NH_2$$

We availed ourselves of Slosvay's modification of Gries' formula.

A tank of a capacity of fifty gallons at a pressure of thirty pounds was filled with air from the laboratory. The air was sent through an air meter which registered one liter per minute and from this into a test tube containing distilled water through which it was allowed to bubble for ten minutes and then tested.

There was no immediate reaction, and only after half an hour's standing did we observe a tinge of color, so faint, however, as to be almost imperceptible in ordinary light. In order to see it we were obliged to back the test tube with pure white filter paper and hold it in the sunlight.

In view of the delicacy of Slosvay's reaction it was fair to assume that the quantity of nitrous acid in the air was so infinitesimally small that for practical purposes it could have no effect in interfering with the subsequent tests for ozone.

Ten liters of oxygen were treated in the same manner. The oxygen was first subjected to two washings in distilled water without giving any reaction to the nitrous acid test. The remaining forty gallons which were afterward liberated in the laboratory were washed in caustic soda and dried with sulphuric acid (c. p.) and bubbled through distilled water. There was no reaction with Gries' test, thus showing that the gas was absolutely pure and free from admixture with nitrous and other gases.

This concluded the preliminary testing. The object of the careful analyzing of the air of the laboratory, as you may already divine, was to devise means of testing for ozone in the open, and so avoid the less satisfactory method used by Schmitt, who treated his ozone in a balloon from which the oxygen had been removed as nearly as possible to do so by means of carbon dioxide, or handling it in a similar glass receiver from which all air had been exhausted, which was the manner in which Kühne conducted his experiments.

For several days work was suspended, and resumed again Monday, August 21, 1892. On that morning we were treated to a genuine surprise that caused me to ponder for awhile; and Dr. J. C. Dittrich, who, perhaps, ranks first among the authorities on ozone in this country, and who kindly assisted me in the chemical portion of my work, prepared several specially sensitive test papers, which on being moistened with distilled water, at once gave a reaction. The air of the laboratory was evidently charged with ozone, and we were at a loss to account for its presence. Speculation was soon set at rest when we recalled the violent thunder storms of the Sunday and Saturday before.

The ozone was the result of the intense static discharges of those days, and the amount that had been generated by the great Pluvius certainly was enormous and beyond measure; for that day and the three succeeding ones work had to be deferred, with all the preliminary testing for naught.

On the following Thursday, on resuming operations, no ozone or nitrous acid was detected in the laboratory, the preliminary tests on being repeated gave results as already stated.

TESTING FOR OZONE IN THE BLOOD.

A rabbit that had been well fed for a week was the subject of investigation. It was a big animal in fine spirits and weighed 4 lb. 3 oz. It was brought into the laboratory and both carotids cut through, and the blood collected in a sterilized glass receiver. In all 60 grammes were extracted and defibrinated with sterilized glass rods. The operation required nine minutes and the fresh serum was subjected to test.

The serum was diluted with distilled water in the proportion of 1 part of serum to 4 of water. With the iodide of starch an immediate reaction was observed in the open air, and the same reaction, faint at first, but gradually deepening in blue color, showed under a bell glass.

Testing with guaiac tincture of the officinal strength, which we reduced by adding an equal volume of absolute alcohol, responded more quickly to reaction of ozone. The blue ring around each drop of blood was marked and sharply defined. The same reaction continued when the test was made under the bell glass, and gradually approached a maximum of intensity at the end of half an hour, when to all appearances the ozone became completely exhausted.

The fibrinous clot with the entrapped corpuscles was likewise tested and gave a far more distinct and marked reaction than the serum.

It was evident at a glance that the corpuscles contained a far larger amount of ozone than the plasma.

The remainder of the defibrinated blood, about 40 grammes, which had been kept in a well covered jar, was next subjected to electrification for five minutes.

A galvanic current of 10 volts and 15 mil-amperes was sent through the fluid. The electrodes used being strips of platinum an inch long and $\frac{5}{8}$ inch wide.

In six seconds the meter dropped to 8 mil-amperes, and the registration which was recorded at the end of each minute read as follows :

1	minute	7	mil-amperes.
2	"	5	"
3	"	4·5	"
4	"	3·75	"
5	"	3+	"

Testing with iodide of starch and guaiac tincture showed the unmistakable increase of ozone. The rings around the drops of blood were of deep blue hue and the reaction continued on with much greater rapidity than was the case of the unelectrified blood. As quantitative test was out of the question, Dr. Dittrich made an approximation of the intensity of the action by comparing the rapidly deepening ring of blue with the chromatic scale given by Dr. Fosci in his exhaustive work on ozone. They carefully noted the change of color as it progressed, availing themselves of the most advantageous light facilities, and agreed upon the estimate that the amount of ozone adequate to such reaction must be in the neighborhood of, at the lowest calculation, at least $2\frac{1}{2}$ times greater than the amount indicated by the reaction in the case of the unelectrified blood. The clot deposited around the electrode at the positive pole gave a more annualed reaction, the ring of blue almost approaching indigo, showing a most marked increase over the former reaction.

Standing by itself this test of the blood outside of the body signifies but little, for it is the blood that circulates through the living organism unimpeded with which we have to deal and in which physiological conditions alone can be of any value in the study of the action of the galvanic current. Yet withal when taken in connection with the tests that were afterward made, the observations form an important link in the chain of evidence that it is animal electricity which is the polarizer of the atoms of neutral oxygen both in the plasma and in the hemoglobin.

Under normal conditions the transformation of O_3 into O_2 is slow and gradual and the polarization of the neutral oxygen is proportionate to the polarizing force of the existing animal electricity.

Undoubtedly Schmitt, Houzeau, Meisner, Kühne and others were right in their assumptions, but it seems to me that they did not probe deep enough for a solution of the possible origin of this transformation of neutral oxygen into ozone within the human economy. It was due to the polarization of the atoms of the neutral oxygen, but how did it come about.

I have assumed, in starting out upon the experiments the results of which form the title of the paper I have the honor of presenting to your consideration, together with the more exact details which I hope to announce at some future day, step by step, with the view of adding some light to the question, that this generation of ozone admits of a satisfactory scientific explanation.

During the years that I have devoted to the study of ozone within the body I have always regarded it with awe and veneration. I have woven theory after theory only to find that the strands broke precisely within the limits of the reasoning of the great observers to whom we owe all I know of ozone, and that to us as physiologists is indeed little.

That ozone can be found in the blood nourished by gases that contain no ozone is a fact beyond dispute, yet the problem of its generation is a problem that at first sight offers no easy solution.

In looking over the field of possible sources to explain this source of formation of ozone, it fastened itself upon me that one great factor that might afford an explanation of its generation had been overlooked. It was animal electricity, and I have tried to explain its function. There seems to be but one deduction to draw from the most careful observation, and that is, that it is animal electricity upon which not only the polarization of the atoms of oxygen, but all molecular polarization and chemical action in the body depends.

I believe that the transformation of oxygen into ozone within the body is brought about by this very animal electricity, which polarizes the neutral oxygen to such a degree that a portion of them rearrange themselves, attract and repel each other under this polarizing force until we get the ozone which we detect upon analysis. The function of the ozone is apparent to all of us. It gives the oxygen increased power to form combinations with the tissue elements and promotes oxidation.

This polarization of the oxygen seems to take place just as the gas touches the tissues where the conditions are favorable to such an action and where it closes circuit with electricity in the human frame. The unaffected molecules of oxygen under the vigorous spurring of this ozone become vitalized, as it were, and at once begin the search for their affinities in the tissues and enter into combination with them.

The proof of this reasoning seems to me to be apparent from the fact that I have been able to appreciably increase the amount of ozone in the blood by passing very weak currents of galvanic electricity through the body, and it is the underlying theory upon which I based my experiments and which I hope to make clear to you.

Before dismissing this portion of my paper and passing over to an account of our experiments upon the blood of the living animal electrified by a current of galvanic electricity, permit me to advance another theory which I regard as justifiable from my findings, and I do so only in the hope that it will give rise to careful discussion, for it is at variance with some of our pet physiological theories. It is that oxygen in the blood, stimulated by the polarizing power of animal electricity, and more so under the stimulus of the galvanic current, enters into combination with the hemoglobin of the corpuscles with a partial transformation into ozone, and that in losing its combining bonds it undergoes a further partial transformation into ozone.

EXPERIMENTS ON THE ELECTRIFIED ANIMAL.

This brings me to a record of the experiments upon the living animal with the galvanic current.

The animal chosen was also a rabbit, which was prepared by being fed on fresh vegetables for several days. He was in prime condition and was allowed to run at large until he was required for use. The batteries were carefully tested cell by cell and the current measured with both volt and mil-ampere meter. A coil of a resistance of 400 ohms, which had been placed in the circuit, was removed after the measurements had been taken, and we decided upon a current of a strength not to exceed 40 mil-amperes.

Two cuts about half an inch apart were made into the skin of the animal, and into these and for a distance into the body of the muscle the platinum electrodes used in the previous experiment were inserted, and a current of 20 volts turned on. The meter showed 44 mil-amperes. This dropped quickly down to 41 mil-amperes. The reading of the meter during the five minutes that the current flowed was as follows :

1	minute	40·5	mil-amperes.
2	"	38	" "
3	"	37+	" "
4	"	35·8	" "
5	"	35	" "

At the end of five minutes both carotids were cut through and 35 grammes of blood were drawn into a sterilized glass vessel and defibrinated as before with sterilized glass rods.

It was observed that the blood was of a brighter scarlet hue than that which flowed from the arteries of the unelectrified animal. Exposure to the air while the process of defibrination was going on did not affect the bright tint. Defibrination, too, was not so easily effected, and the fibrine slowly gathered around the rods.

Seven minutes after the blood was shed a gramme of the fresh serum was diluted with two grammes of distilled water and subjected to tests with both guaiac and starch iodide. The reaction in both instances was almost immediate, a trifle more active with the guaiac. The ring of blue around the drops of blood was more pronounced and much deeper, and kept on deepening both in the open air and under the bell jar as had been done with the blood from the first animal killed. At the end of 20 minutes the test papers, those saturated with guaiac and starch iodide, three of each variety being exposed to the air and a similar number under bell jars, indicated the termination of the action, and they were taken out and carefully compared with the test records of the first experiment, which had been preserved in airtight tubes. The blue ring was even upon the most superficial examination found to be several shades deeper, and the ring of reaction was more spreading, in some of the drops almost half an inch wide and distinctly visible to the line of demarcation of chemical action. The fibrin also gave like results. A far larger amount of iodine had been set free in these tests than in the case of the first analysis. The quantity of ozone to give such reaction, according to a most conservative calculation of Dr. Dittrich, was estimated to be certainly three times greater than that which gave the reaction from the normal blood. The increase in the amount of ozone was astonishing and far beyond our expectations. We had anticipated some difficulty in determining the increase if it proved to be trifling, but here we were met by a quantity far in excess of what we had hoped to find, in the event of the most successful termination of our searching.

The action of the current on the oxygen in both the plasma and corpuscle enmeshed fibrin was evident in the transformation of a portion of it into the more vital form of O_3. That the current had accomplished this transformation, astonishing as it proved to be, was readily to be explained, but not so with the ozone in the normal blood. There was but one explanation for this—the polarizing action of the animal electricity.

MY PLAIN VIEWS REGARDING ANIMAL ELECTRICITY.

The existence of animal electricity is acknowledged. Its origin and action, however, are the points upon which electro-physiologists are not quite clear. Those who have given the subject some consideration dismiss it by establishing its connection between chemical action, heat and animal electricity. They rest contented in discussing the three conditions without attaching the slightest importance to the precedence of one or the other of them. Chemical action, we are told, evolves heat, and so tissue metamorphosis and oxidation go on. They are satisfied with the evidences of the existence of animal electricity, that it can be measured, and that it is one of the great trinity upon which life rests.

It is in view of this condition of the investigations

* Read before the Twelfth International Medical Congress, Moscow, Russia, August 19, 1897. By special invitation.

† Ber. d. Chem. Gesell., 15, 425; 15, 2191.

‡ Bulletin de la Société Clinique de Paris, September and November, 1889.

upon this question that I approach it with much trepidation and fear, lest I be charged with being too radical in my deductions. I can almost see doubt written upon the faces of many of this distinguished gathering and I can almost hear you say: Well, are you going to settle this question? Settle the question or not, still I have the boldness to advance a probable solution of the problem, and I ask you to follow closely my experimentation and the deduction I have drawn and based my opinions upon. I will not take up your time by rehearsing the observations of the various electro-physiologists who have enlightened us in animal electricity. To do so I would in fairness to all be obliged to begin with Matteucchi and so on up to the present day without omitting a single one, for each of the observers has welded a link in the chain of results, and to leave out a link would mean to destroy the integrity of the chain.

Let us for a moment consider the observations of Dutrochet and we may get a clew to the true function of animal electricity. He observed that if the positive pole of a battery be dipped into pure water and the negative in gum water, endosmosis continued more energetically.

Onimus later on discovered that with a reversal of this order of poles, endosmosis too was reversed. It is but fair, reasoning again by analogy, to assume that the electricity in the body exercises precisely the same physico-chemical action. I have already called your attention to the observations of Gay-Lussan. Whenever the so-called catalytic action takes place in the living tissue, is it not equally fair to assume that animal electricity is the prime mover? Can there be any question that electricity, a form of galvanic, with its electrolytic powers, of the ready manner with which it decomposes the salts, coagulates albumen in the vessels of our laboratories, has a like action on the tissues and fluids of the living organism?

It is apparent I hold that animal electricity not only influences the whole system of nutritive operations but also directs them.

Time and again I have electrified human beings and animals and observed that under certain conditions of electrification the animals and beings threw off a greater amount of urea and carbonic acid than under ordinary conditions.

Urea and carbonic acid! And what is the significance of such an increase in the waste products?

Nothing more and nothing short of increased chemical action, increased tissue metamorphosis, the increased evolution of heat; but the electricity, the animal electricity, that remains unaccounted for. Dutrochet and Onimus showed us the action of the anode and the cathode in endosmosis, and left us to apply it to the physiology of nutrition. Now let us do so, and account for the function of animal electricity if we can. As I have already intimated, the order of act on is animal electricity first, and why? Because we must have polarity before we can have chemical action and its natural result, heat.

Subject a solution of the iodide of potassium to electrification and you free the iodine. Inject a quantity of this fluid into the blood of a living animal and then subject the animal to electrification, and, in a very few minutes, starch papers held near in contact with the parts surrounding the positive pole will indicate that the iodine is set free by the action of that pole. Note the transfer of the chemical action from the laboratory to the living body—are the two not singularly alike?

Unfortunately, I have not been able to isolate the poles of animal electricity, and hence it is that my tests on animals similarly injected, yet not electrified, give me such indistinct reactions that we hesitate to announce them as positive results.

Yet all this points to the one conclusion and the one deduction—that animal electricity comes first; that is, the prime factor in all the processes of change, of chemical action or otherwise, within the living body. That without its stimulus of polarization, no chemical action can be called into life, and, consequently, none can go on, and tissue metamorphosis, which is life itself, must cease.

Before concluding, allow me a word or two upon ozone, its physiological and therapeutical value, which are not under discussion, and are hardly properly to be considered in the limits of this paper. We have dealt with ozone generated from the oxygen within the body, and it is in this form that it plays its so important role in the oxidation of the tissues. There seems to be some doubt as to the possibility of introducing ozone in its pristine integrity into the system. It may be a feat within the range of possibility, judging from the voluminous literature upon the subject that has been published only within the last year or more; yet, from my experience in handling it, I prefer to regard it as an agent that performs its most useful work upon the field where it is ushered into existence, where nature calls it into life because it is needed to perform important duties.

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